EXHIBIT A

US010136503B2

(12) **United States Patent**
Chen

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(45) **Date of Patent: *Nov. 20, 2018**

(54) **MICROCONTROLLER-BASED MULTIFUNCTIONAL ELECTRONIC SWITCH AND LIGHTING APPARATUS HAVING THE SAME**

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(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/702,837**

(22) Filed: **Sep. 13, 2017**

(65) **Prior Publication Data**

US 2018/0070425 A1 Mar. 8, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/292,395, filed on Oct. 13, 2016, now Pat. No. 9,795,008, which is a (Continued)

(30) **Foreign Application Priority Data**

Oct. 15, 2012 (TW) .... 101137918 A

(51) **Int. Cl.**
H05B 37/02 (2006.01)
H03K 17/13 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H05B 37/0227*** (2013.01); ***H03K 17/133*** (2013.01); ***H03K 17/941*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H05B 37/0227; H05B 33/0815; H05B 33/0854
(Continued)

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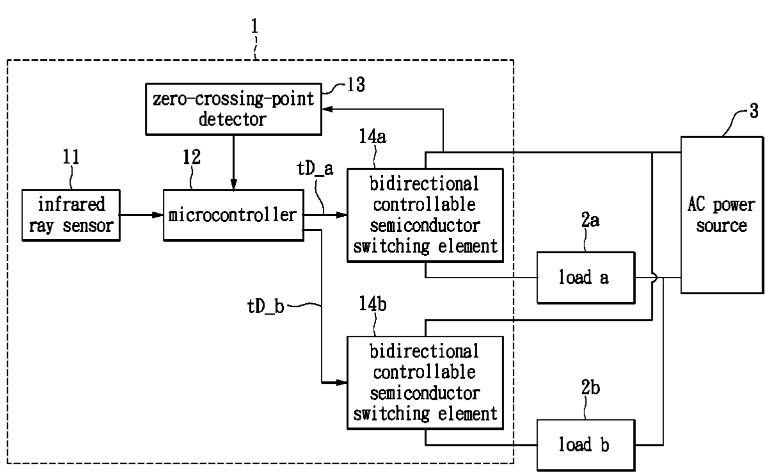
Primary Examiner — Thuy Vinh Tran
(74) *Attorney, Agent, or Firm* — Li & Cai Intellectual Property (USA) Office

(57) **ABSTRACT**

A microcontroller-based multifunctional electronic switch for lighting control uses a detection device to sense and convert at least one external control signal into at least one message carrying sensing signal interpretable to a microcontroller. Based on a signal format of the message carrying sensing signal received, the microcontroller recognizes working mode chosen by the external control signal and thereby executes an appropriate lighting control process. The system and method of the present invention may be equally applicable to detection design, such as touch less and direct touch interface implemented by infrared ray sensor, push button or wireless control device in conjunction with APP preloaded, for performing multiple working modes including on/off mode, dimming mode, color temperature tuning mode, color temperature switching mode, color temperature dim to warm mode, commanding mode for controlling a lighting family comprising a plurality of member lamps remotely located or delay shut off mode.

110 Claims, 19 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/095,540, filed on Apr. 11, 2016, now Pat. No. 9,497,834, which is a continuation of application No. 14/579,248, filed on Dec. 22, 2014, now Pat. No. 9,345,112, which is a continuation-in-part of application No. 13/792,002, filed on Mar. 9, 2013, now Pat. No. 8,947,000.

(51) **Int. Cl.**

H03K 17/94	(2006.01)
H05B 39/08	(2006.01)
H05B 33/08	(2006.01)
F21Y 115/10	(2016.01)
F21V 3/00	(2015.01)

(52) **U.S. Cl.**

CPC ***H05B 33/0815*** (2013.01); ***H05B 33/0854*** (2013.01); ***H05B 33/0863*** (2013.01); ***H05B 37/0272*** (2013.01); ***H05B 39/08*** (2013.01); *F21V 3/00* (2013.01); *F21Y 2115/10* (2016.08); *Y02B 20/44* (2013.01); *Y10T 307/25* (2015.04); *Y10T 307/766* (2015.04); *Y10T 307/773* (2015.04); *Y10T 307/826* (2015.04)

(58) **Field of Classification Search**

USPC 315/159, 360, 362; 340/541, 567

See application file for complete search history.

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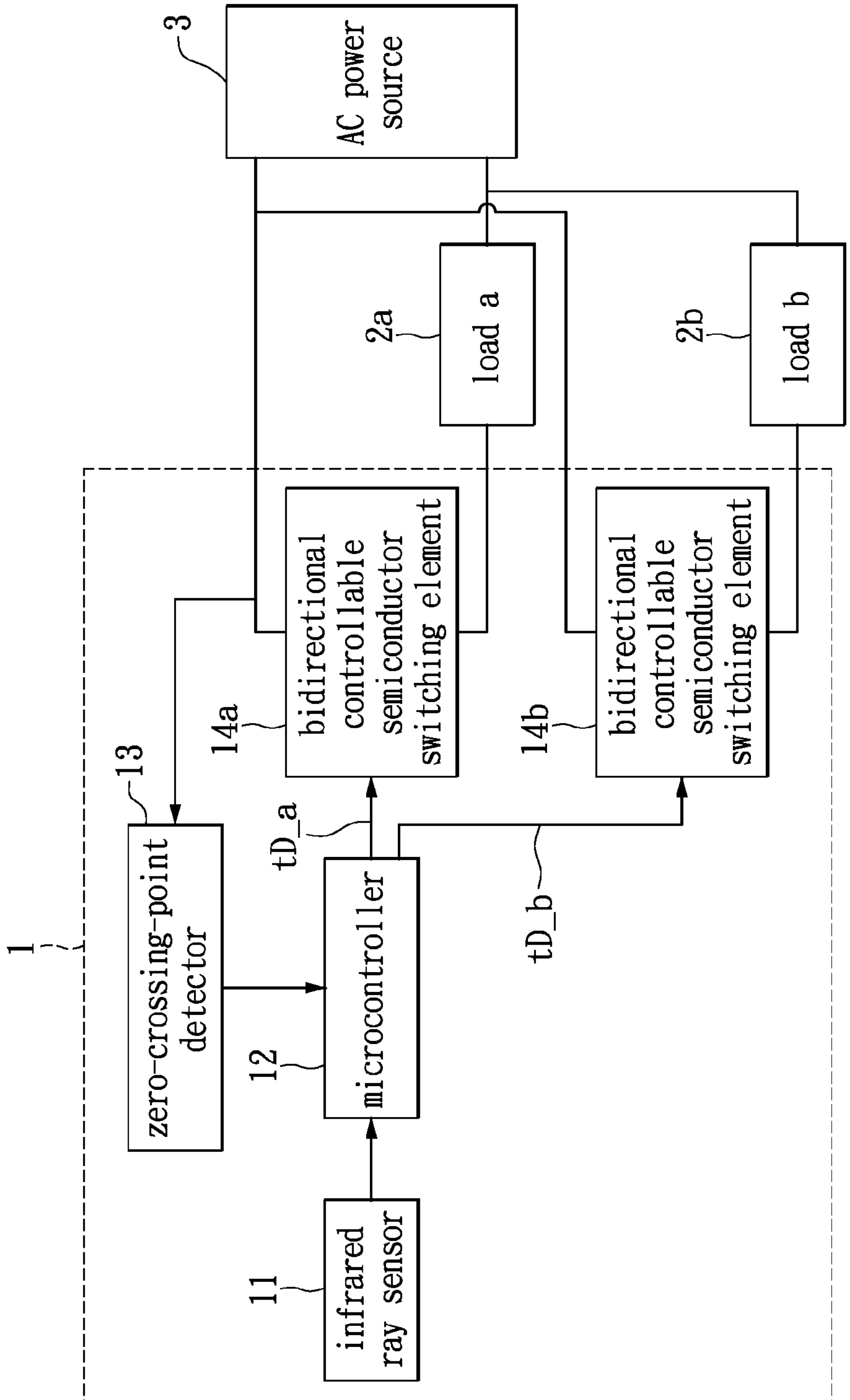
3
AC power source
2a
load a
2b
load b
1
13
zero-crossing-point detector
14a
bidirectional controllable semiconductor switching element
14b
bidirectional controllable semiconductor switching element
tD_a
tD_b
12
microcontroller
11
infrared ray sensor

FIG. 1

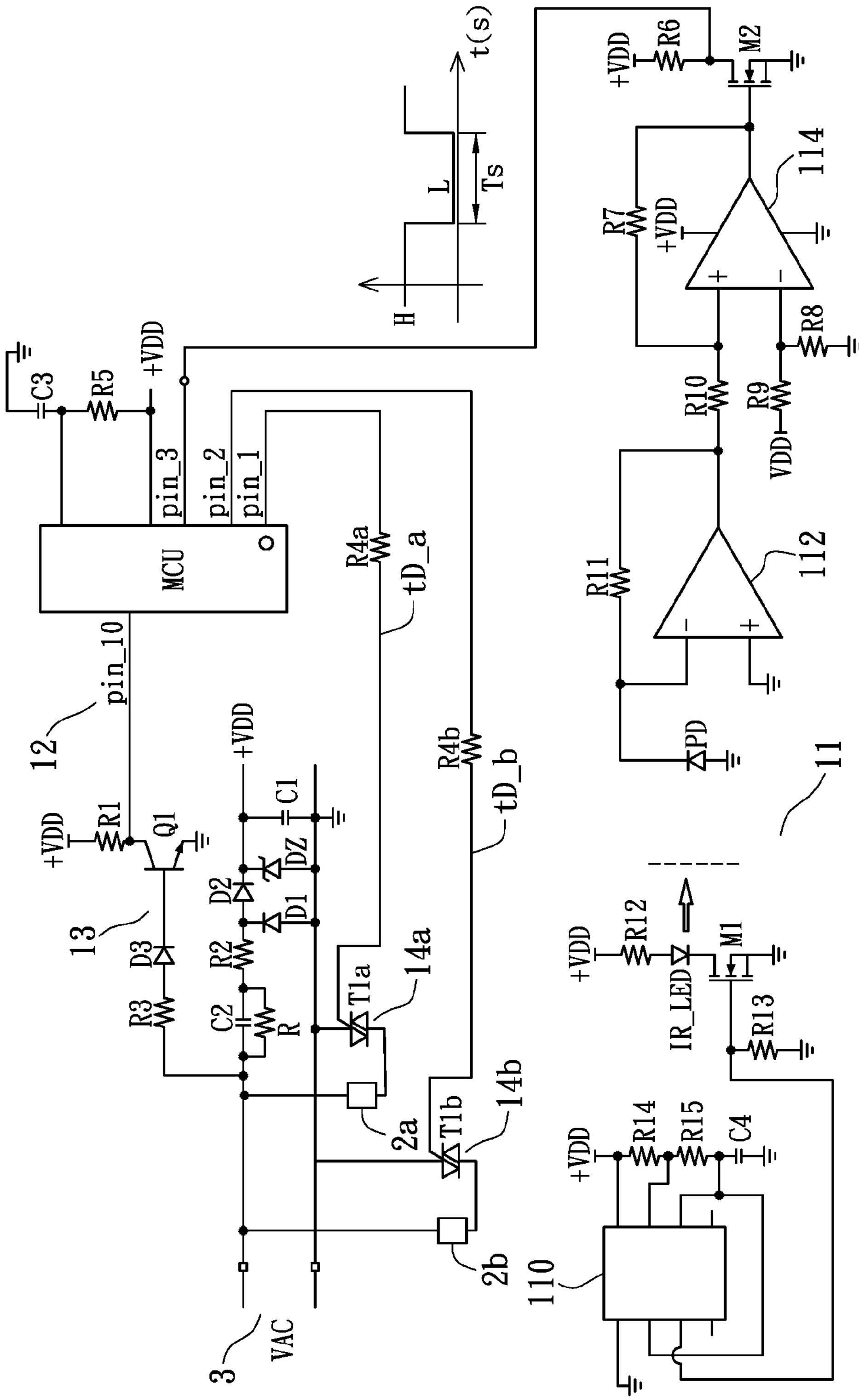
MCU
pin_10
pin_3
pin_2
pin_1
12
13
11
110
112
114
3
VAC
2a
2b
14a
14b
T1a
T1b
tD_a
tD_b
R4a
R4b
Q1
R1
R2
R3
D1
D2
D3
DZ
C1
C2
R
C3
R5
+VDD
R6
M2
R7
R8
R9
R10
R11
PD
R12
IR_LED
M1
R13
R14
R15
C4
VDD
H
L
Ts
t(s)

FIG. 2

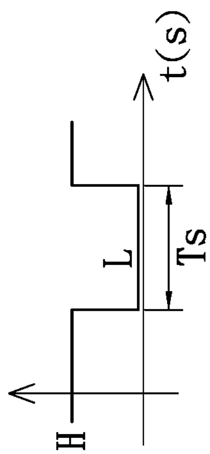

FIG. 3B

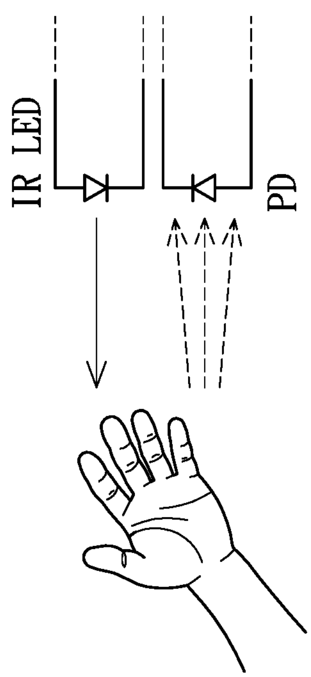

FIG. 3A

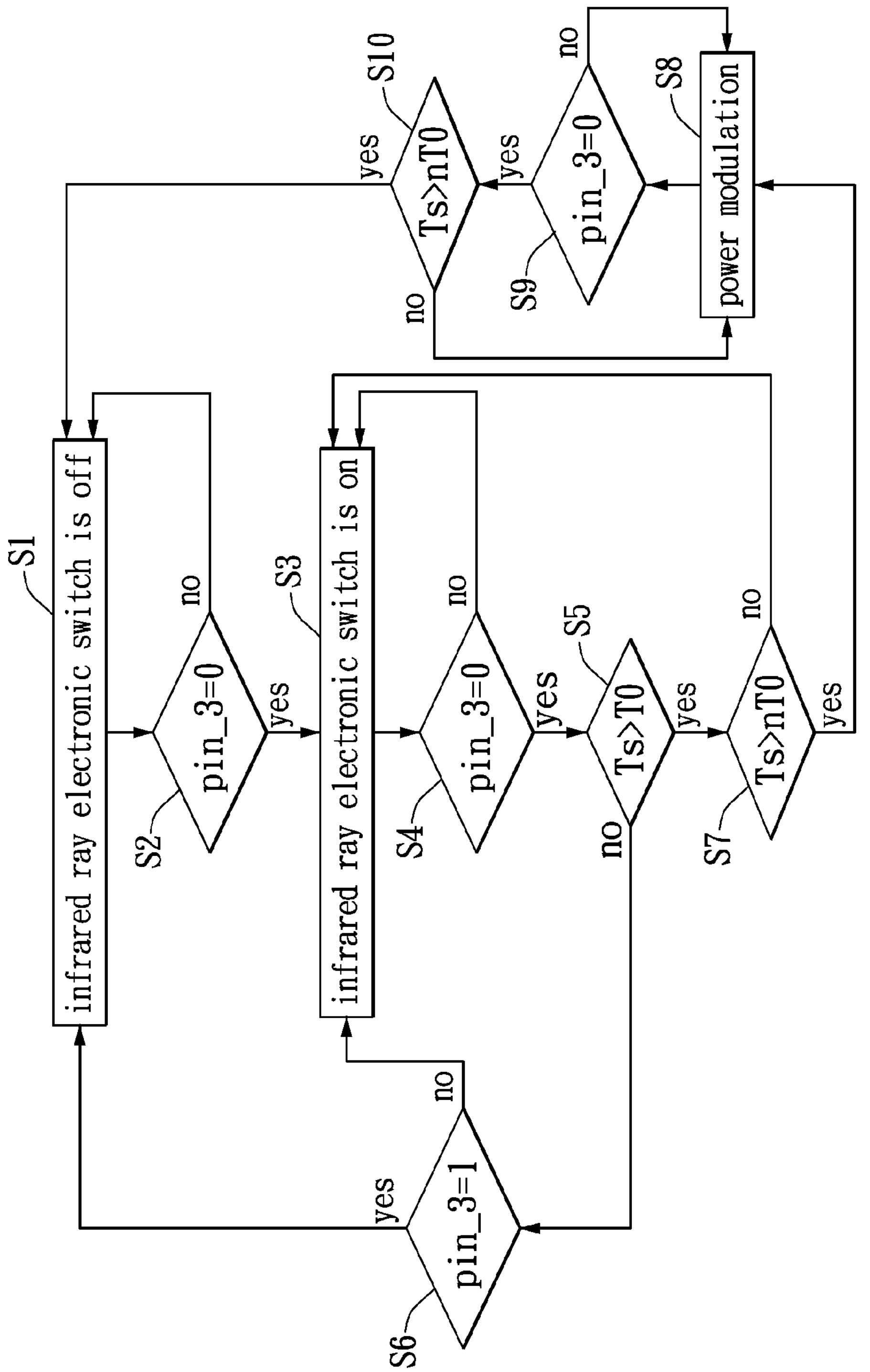
S1
infrared ray electronic switch is off
S2
pin_3=0
yes
no
S3
infrared ray electronic switch is on
S4
pin_3=0
yes
no
S5
Ts>T0
yes
no
S6
pin_3=1
yes
no
S7
Ts>nT0
yes
no
S8
power modulation
S9
pin_3=0
yes
no
S10
Ts>nT0
yes
no

FIG. 4

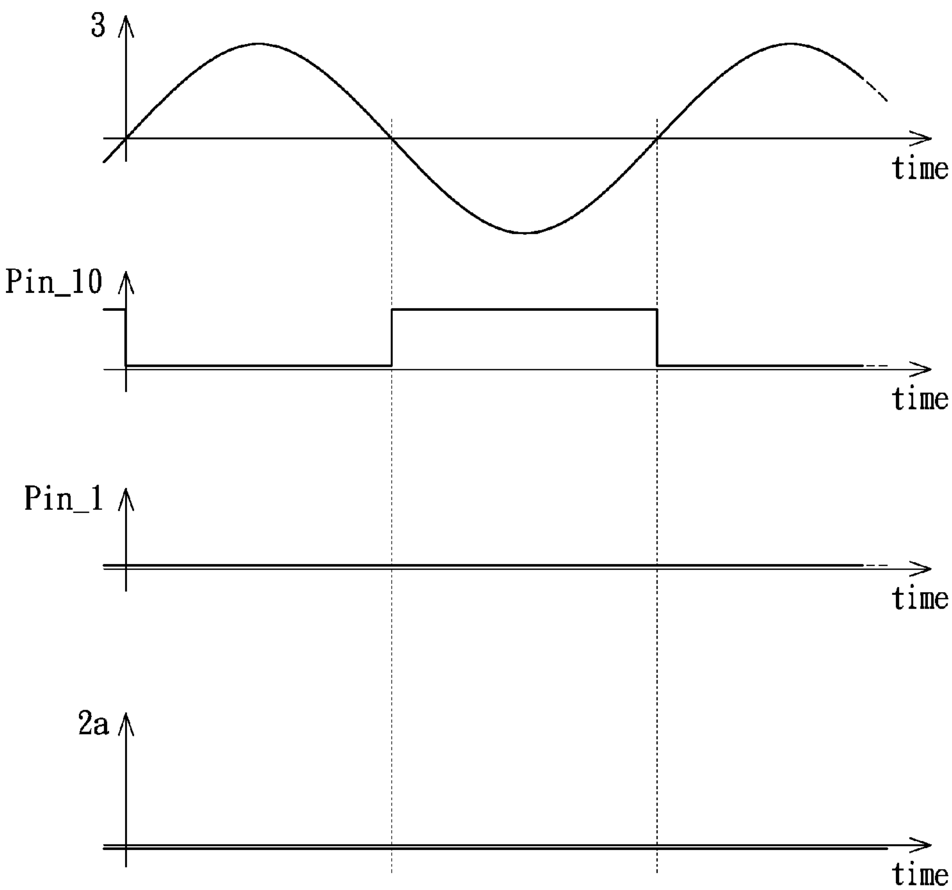

FIG. 5

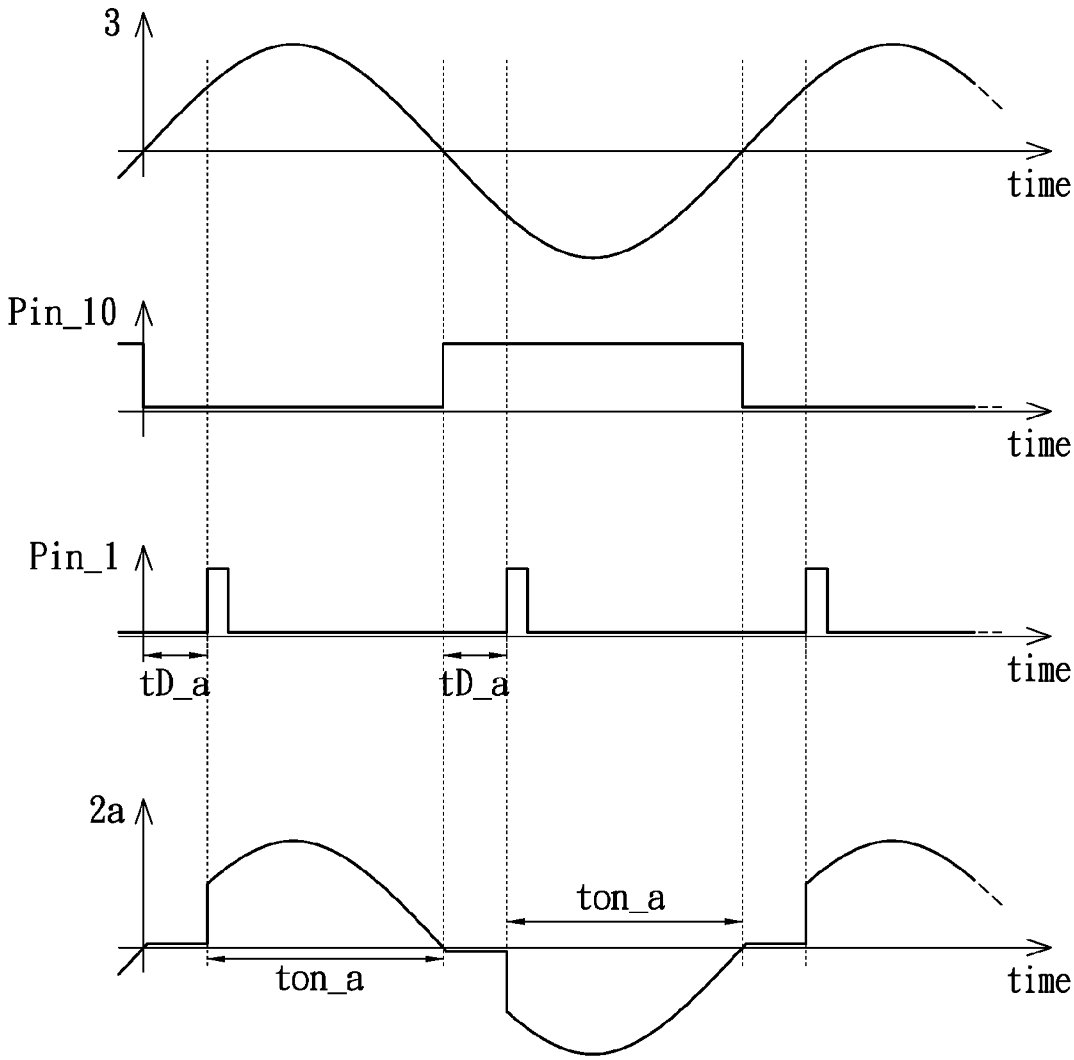

FIG. 6

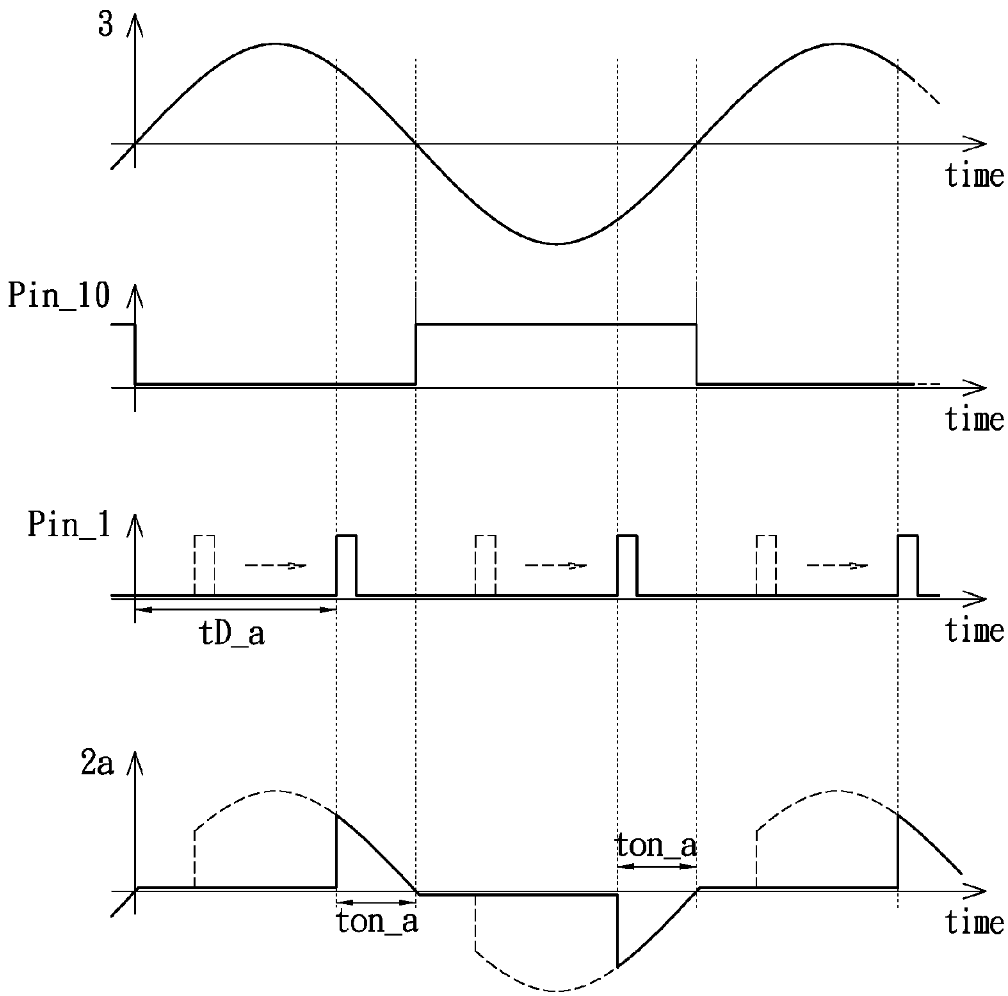

FIG. 7

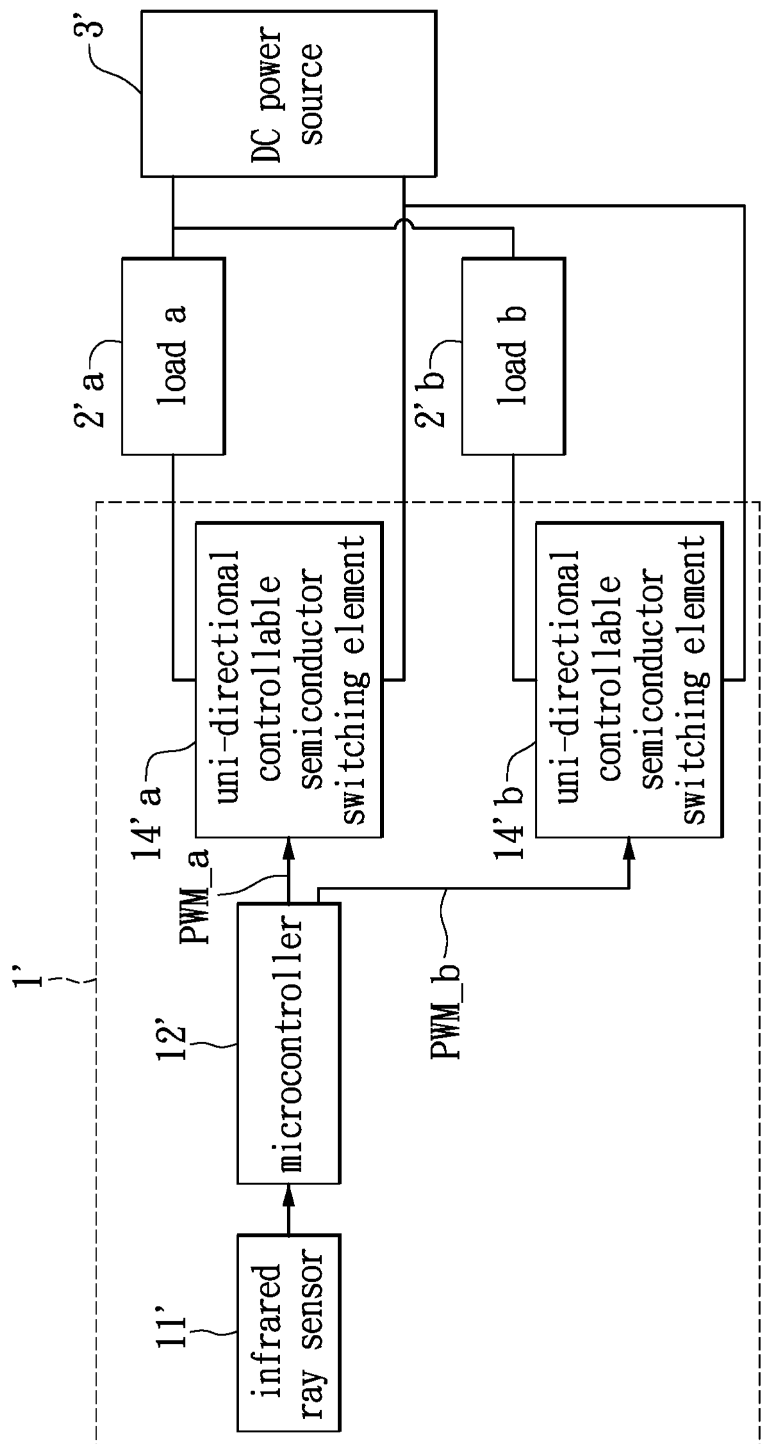
3'
DC power source
2' a
load a
2' b
load b
1'
14' a
uni-directional controllable semiconductor switching element
14' b
uni-directional controllable semiconductor switching element
PWM_a
PWM_b
12'
microcontroller
11'
infrared ray sensor

FIG. 8A

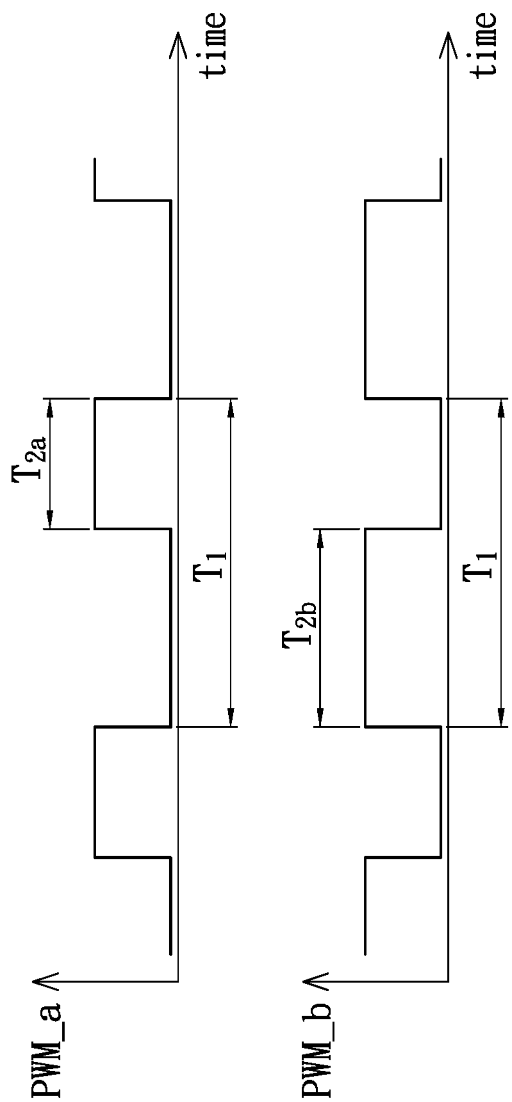

FIG. 8B

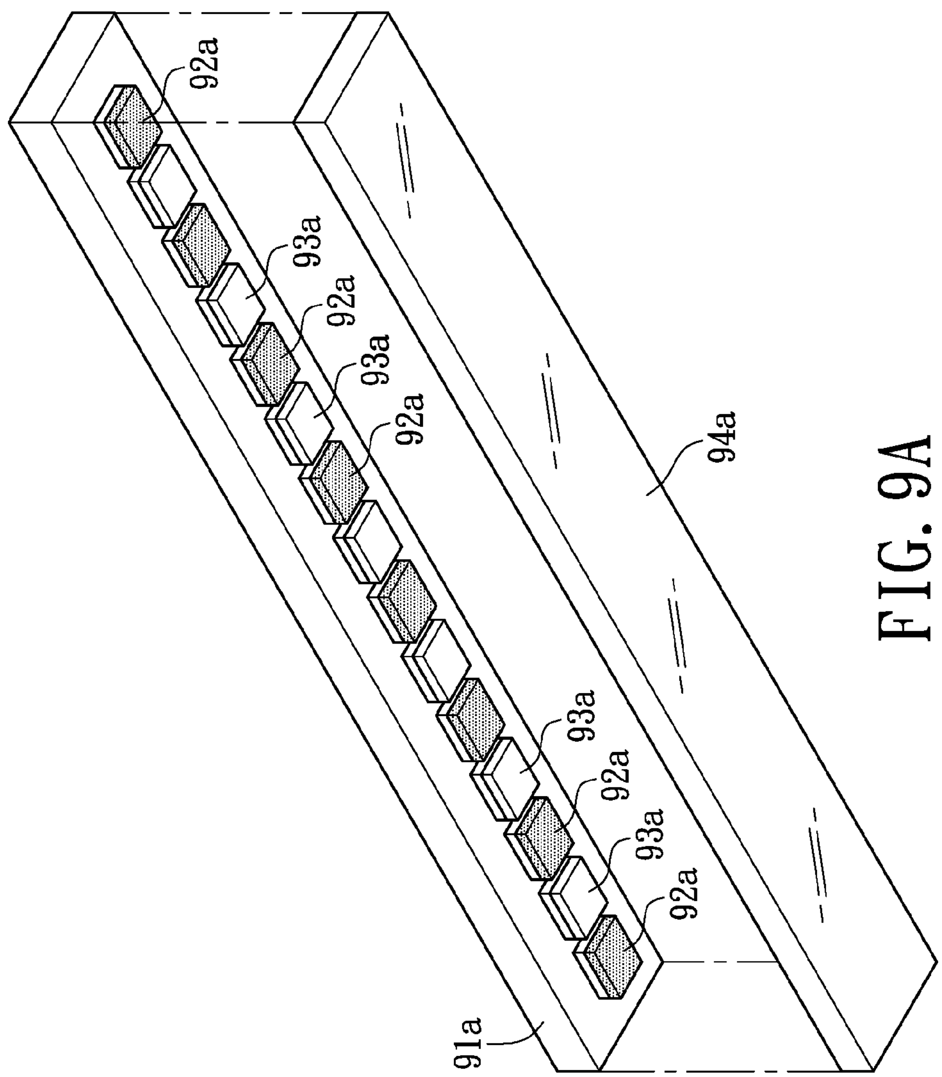

FIG. 9A

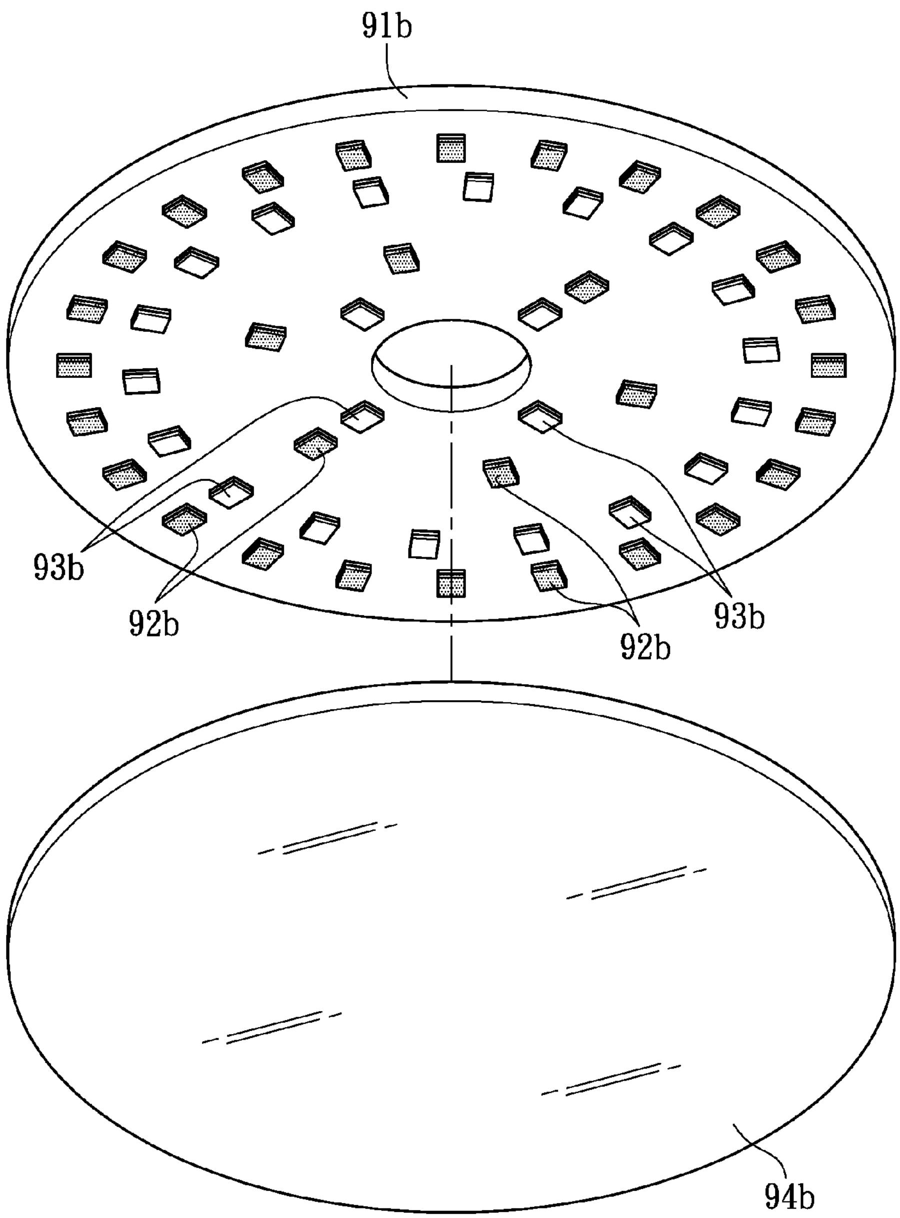

FIG. 9B

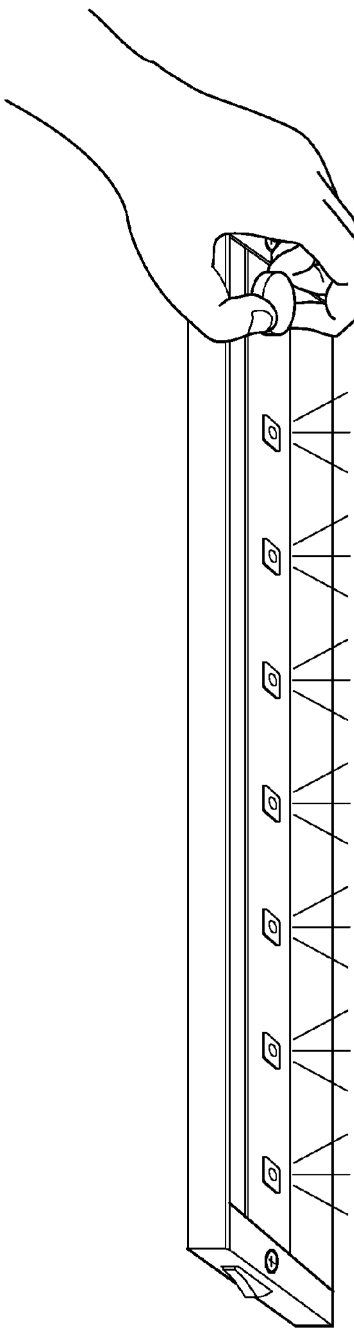

FIG. 10A
(PRIOR ART)

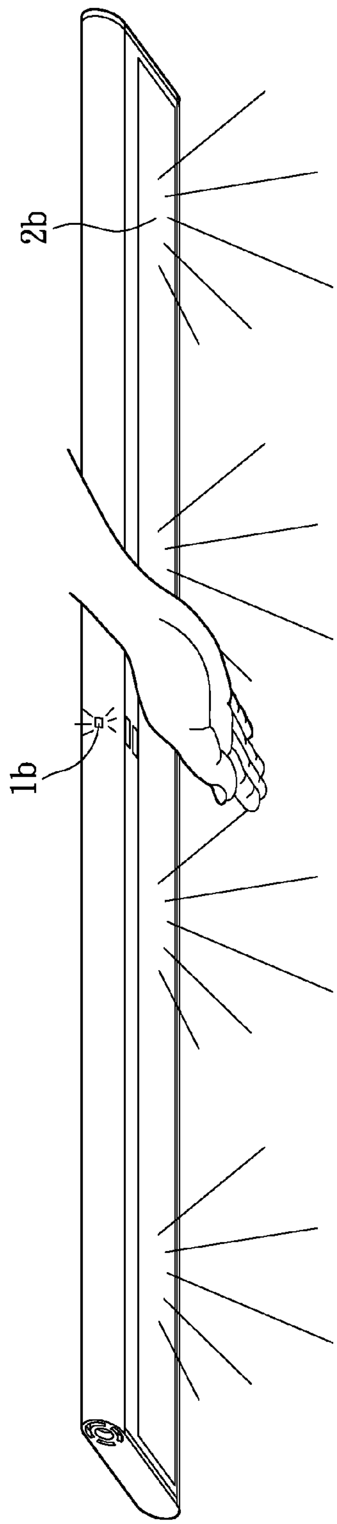

FIG. 10B

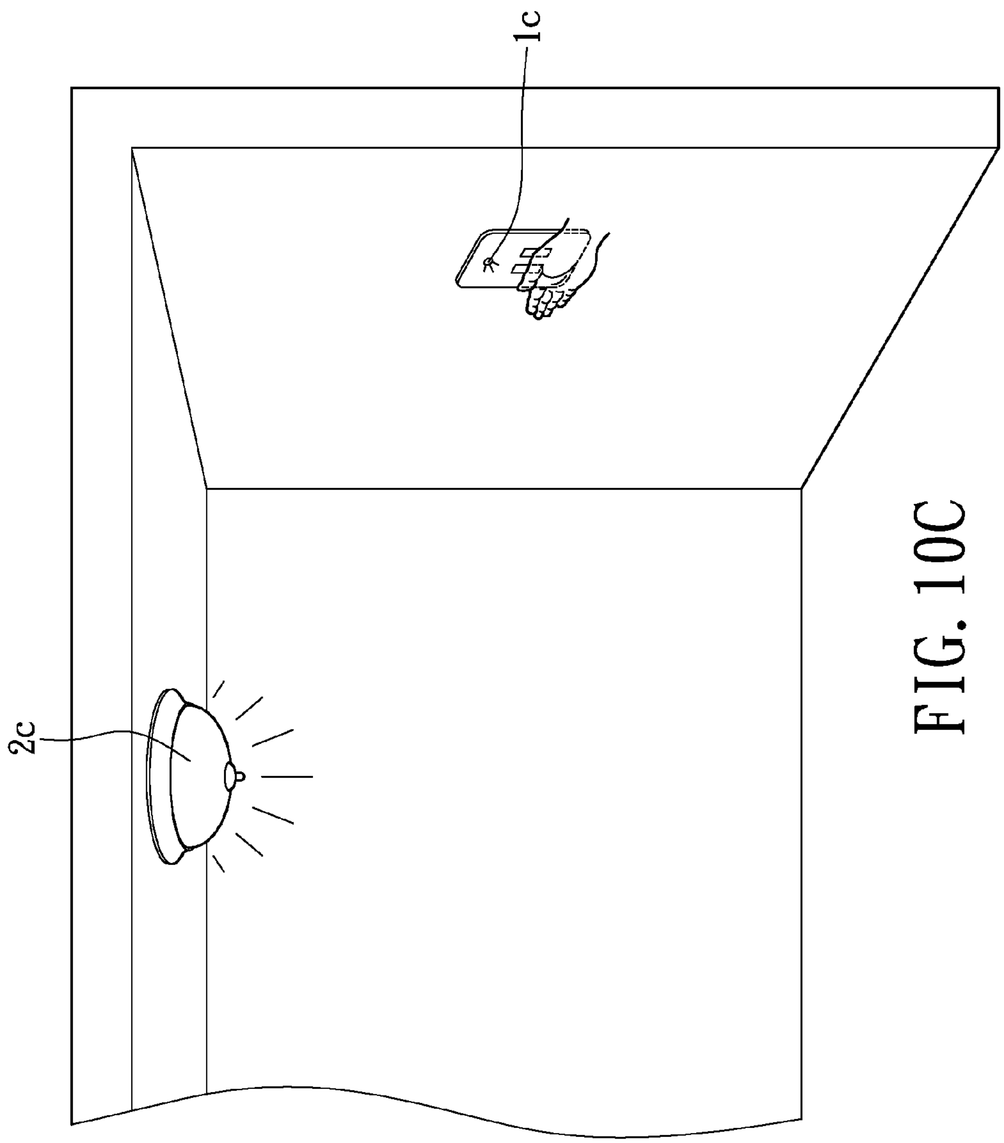

FIG. 10C

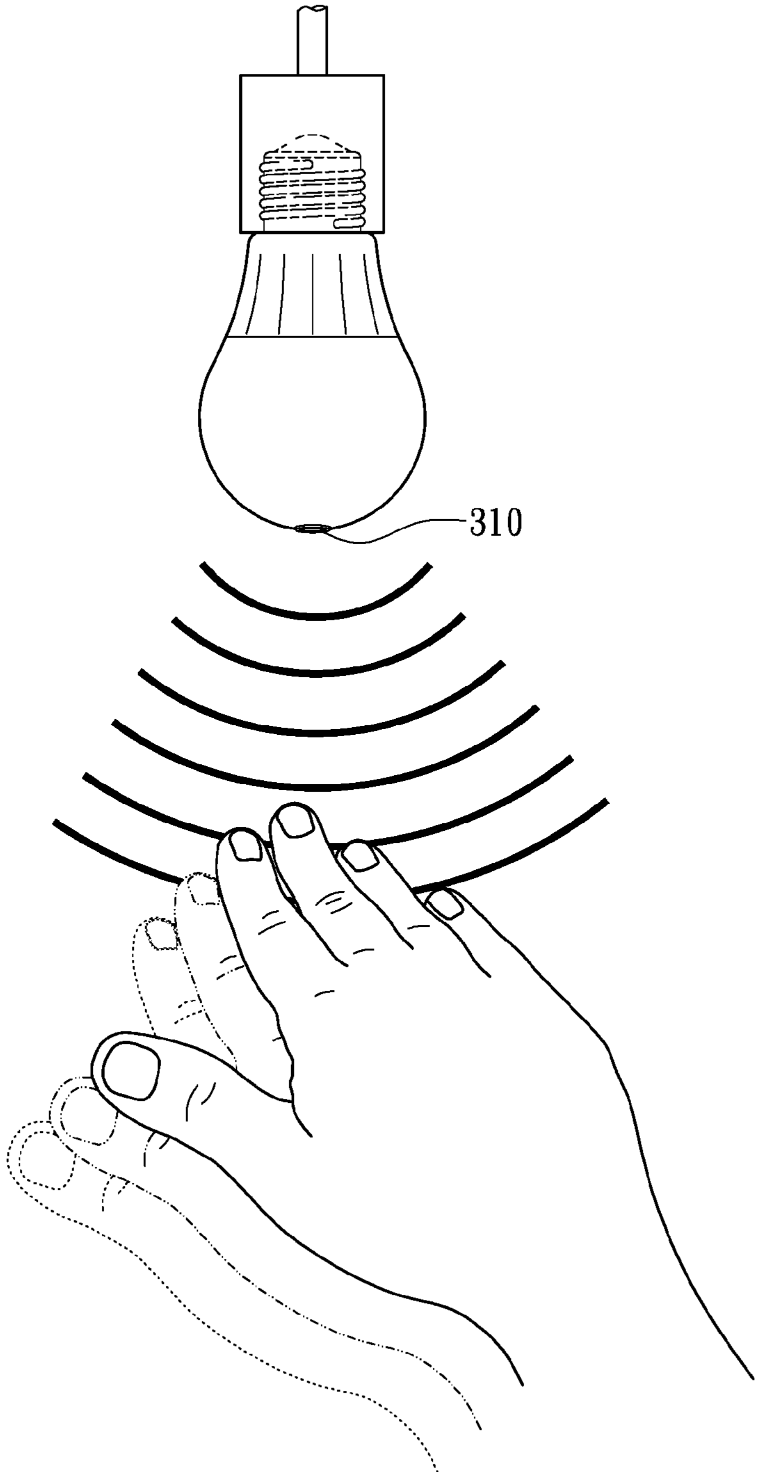

FIG. 10D

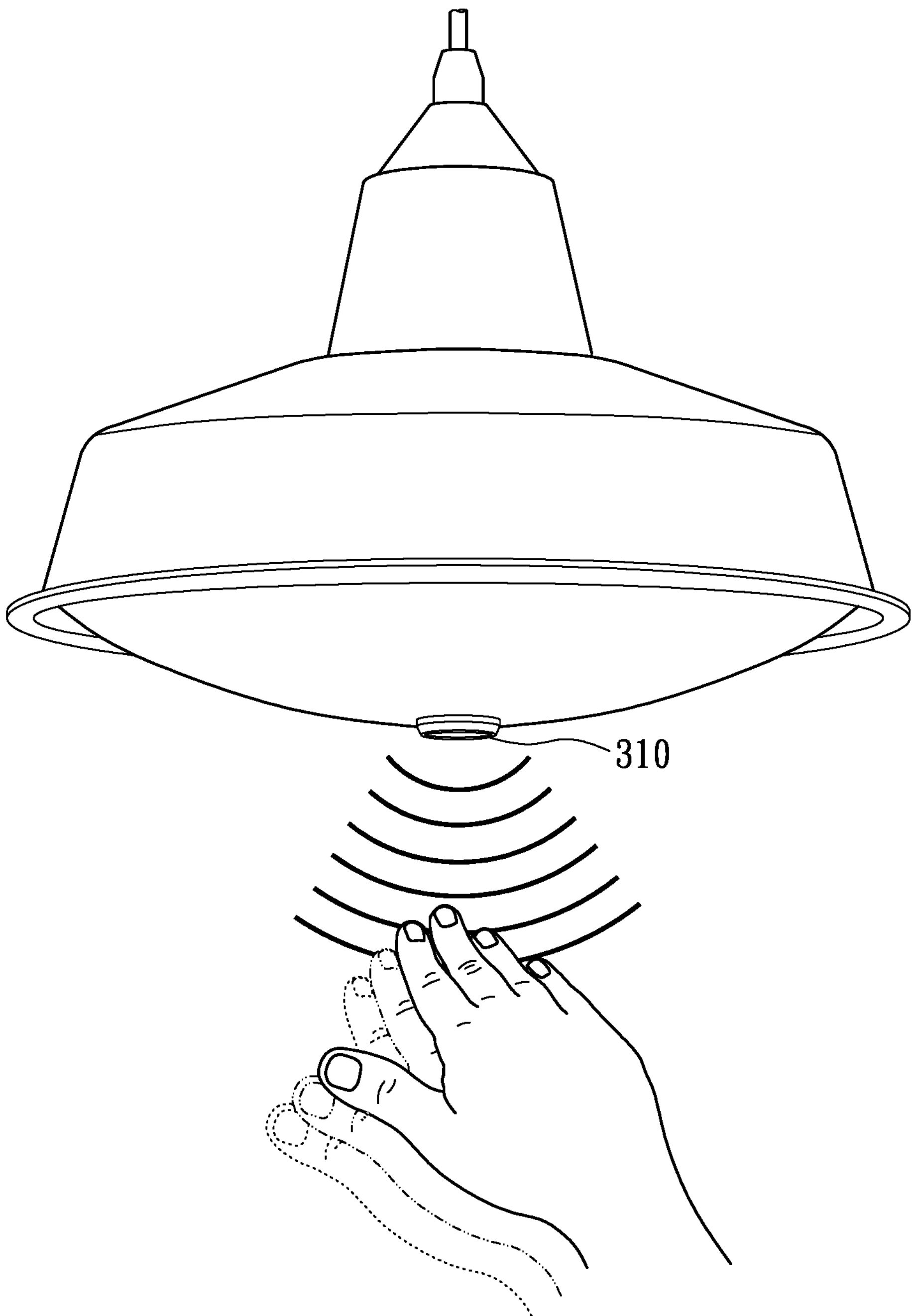

FIG. 10E

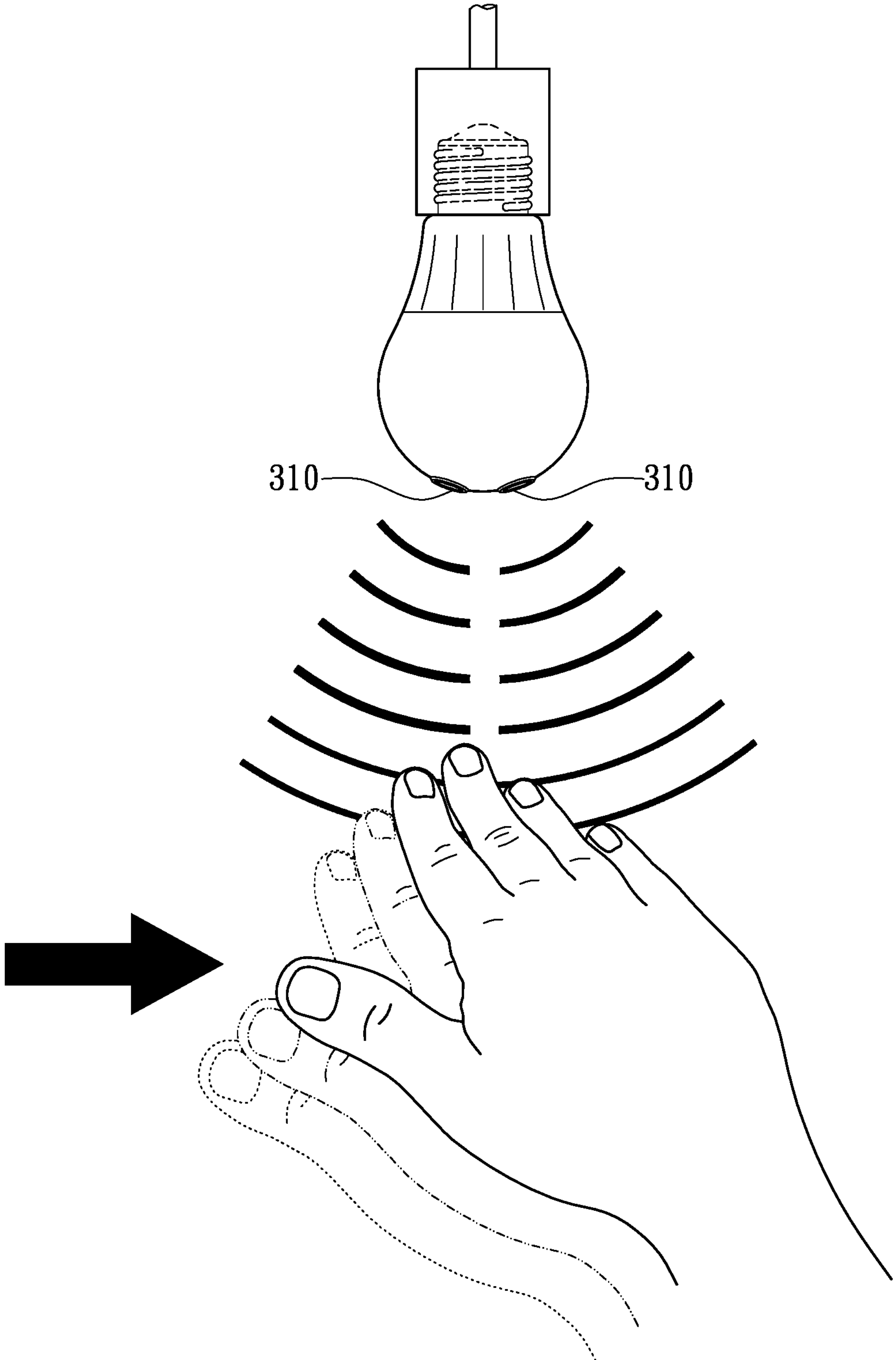

FIG. 11A

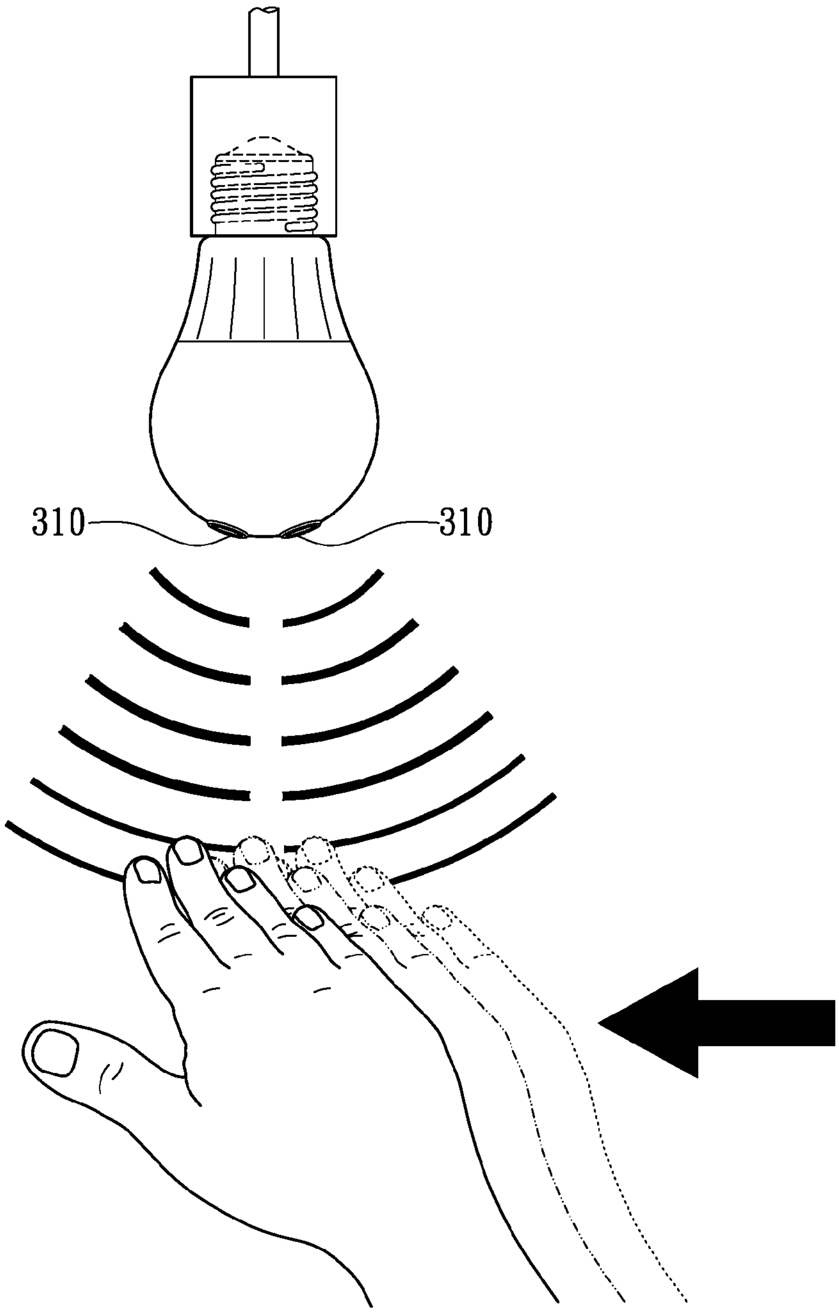

FIG. 11B

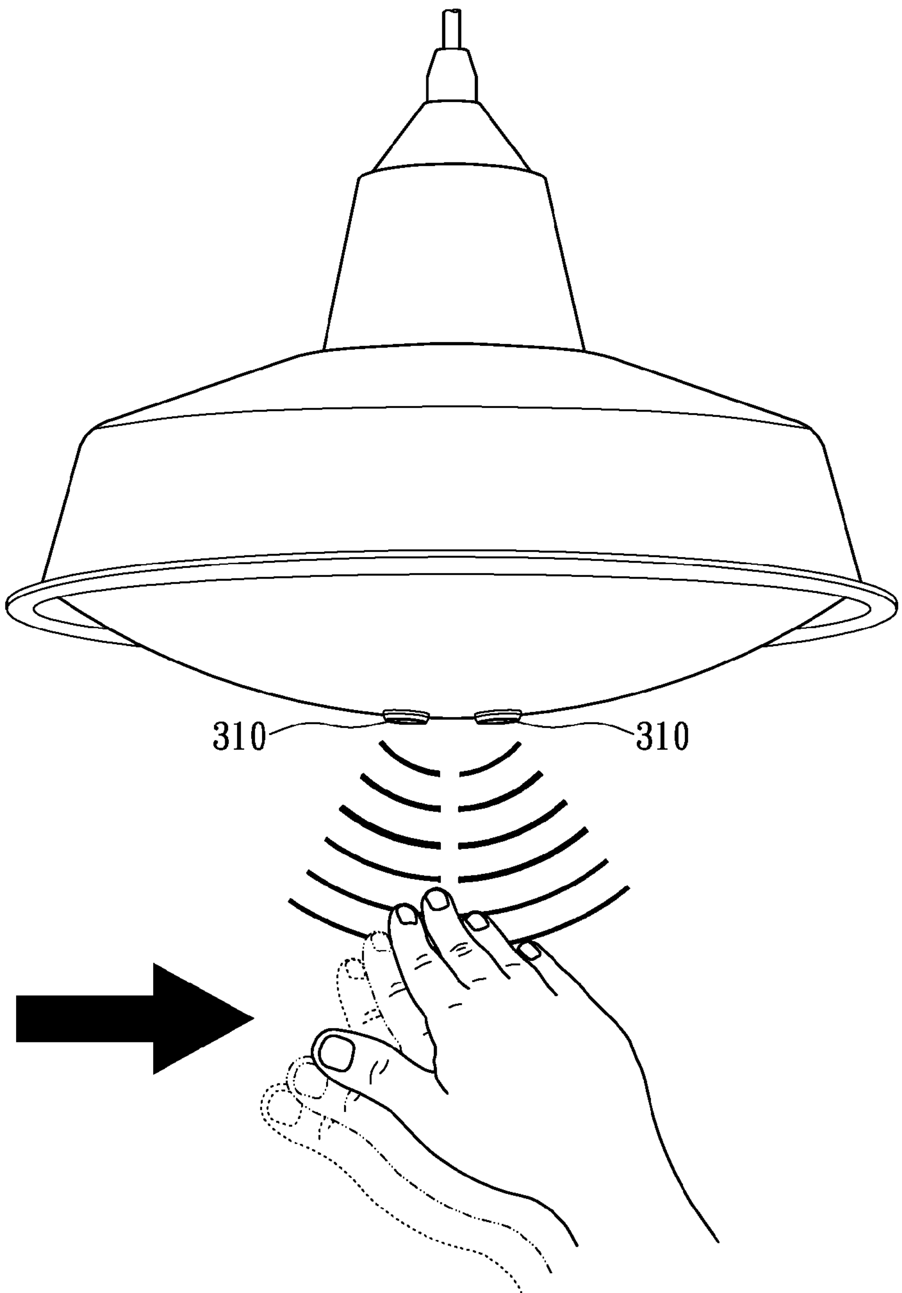

FIG. 11C

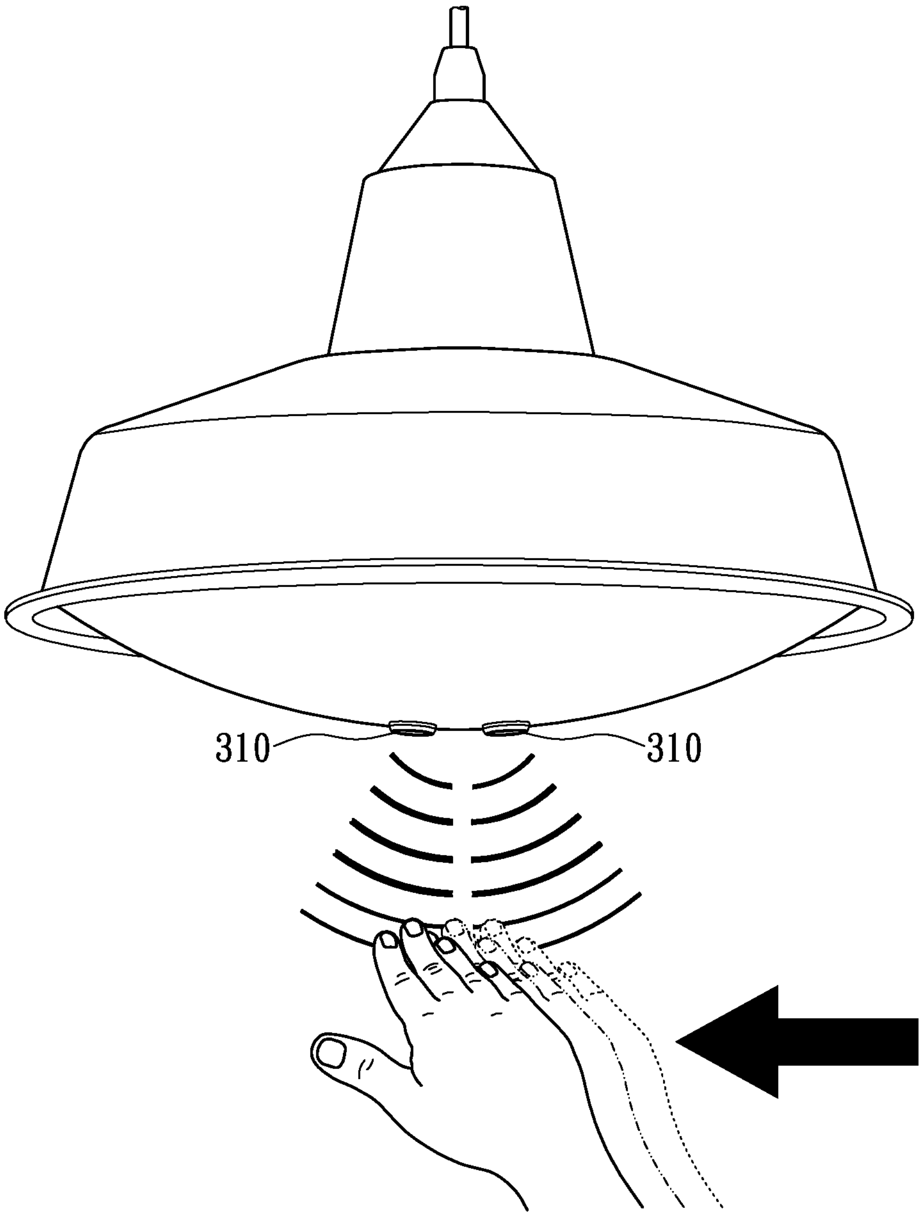

FIG. 11D

MICROCONTROLLER-BASED MULTIFUNCTIONAL ELECTRONIC SWITCH AND LIGHTING APPARATUS HAVING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This Application is a continuation application of prior application Ser. No. 15/292,395 filed on Oct. 13, 2016, now U.S. Pat. No. 9,795,008. The application Ser. No. 15/292,395 is a continuation application of prior application Ser. No. 15/095,540 filed on Apr. 11, 2016, now U.S. Pat. No. 9,497,834. The application Ser. No. 15/095,540 is a continuation application of prior application Ser. No. 14/579,248 filed on Dec. 22, 2014, now U.S. Pat. No. 9,345,112 B2. The U.S. Pat. No. 9,345,112 B2 is a continuation-in-part of Non-provisional application Ser. No. 13/792,002 filed on Mar. 9, 2013, now U.S. Pat. No. 8,947,000 B2.

BACKGROUND

1. Technical Field

The present disclosure relates to a technology using a microcontroller with program codes designed to provide a user friendly solution for performing on/off switch control, diming control, and timer management for a lighting apparatus or an electrical appliance.

2. Description of Related Art

A mechanical-type electric switch is a manually operated electromechanical device. Its function is based on attaching or detaching two metal conductors to produce a short or open circuit, respectively. This mechanical-type switch is not suitable for installing in a space where has the concern of gas explosion, because an instantaneous surge current, produced by suddenly engaging or releasing the metallic contact of the switch, may generate electric sparks to ignite fire.

A controllable semiconductor switching element, such as a triac, has nearly zero voltage between two output-electrodes in conduction mode and nearly zero current through two output-electrodes in cut-off mode. Solid state electronic switch utilizing the above unique features of triac for circuit on/off switch control can avoid generating electric arc, since the main current pathway of the solid-state switch is not formed by engaging the two metal conductors. It becomes a much better choice than mechanical-type electric switch from the stand point of safety consideration.

Solid-state electronic switches are constructed with various methods to trigger controllable switching element, like triac or thyristor, into conduction or cutoff for desired electric power transmission. For example, U.S. Pat. No. 4,322,637 disclosed a technique using optical coupling element to control bi-directional thyristor or triac in conduction or off state; or another U.S. Pat. No. 6,285,140B1 disclosed a technique using microcontroller incorporated with zero-crossing-point detector to generate AC-synchronized time-delay pulse to control triac in on or cut-off state so as to transmit variable electric power to a light-emitting diode load.

Mostly a mechanical toggle or spring button of similar setup is usually applied on the electronic switch to facilitate manual on/off switch operation. The operation of electronic switch with mechanical toggle means an inevitable contact by hand which is not appropriate in working places such as kitchens or hospitals. To relieve concerns of contagion or contamination resulted through hand contacts, touchless switches are developed. For example, U.S. Pat. No. 5,637,863 disclosed a technique utilized infrared sensor to activate electronic switch to operate on/off switch control, and even dimming control presumably by modifying its circuit design.

In retrospect, the above mentioned prior arts have however still some drawbacks. For instance, U.S. Pat. No. 5,637,863 used a complicated infrared sensor construction and circuit design; or U.S. Pat. No. 6,285,140B1 did not resort to an efficient control of electric power transmission from power source to various electric impedances which is required in lighting apparatus.

SUMMARY

An exemplary embodiment of the present disclosure provides a microcontroller based electronic switch for detecting an external motion signal. The microcontroller based electronic switch comprises a first controllable switching element, a second controllable switching element, a detection device and a microcontroller. The first controllable switching element is electrically connected between a power source and a first lighting load for emitting light with a first color temperature. The second controllable switching element is electrically connected between the power source and a second lighting load for emitting light with a second color temperature. The detection device is for detecting an external motion signal played by a user and converting said external motion signal into a message carrying sensing signal. The microcontroller with program codes is written and designed to read and interpret the message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is electrically connected between said second controllable switching element and said detection device. Said microcontroller controls a conduction state or cutoff state of said first controllable switching element and said second controllable switching element according to said message carrying sensing signal generated by said detection device. When the first controllable switching element and the second controllable switching element are in the conduction state, said microcontroller further controls electric power transmission levels from the power source to the first lighting load and the second lighting load according to specific format of said message carrying sensing signal received from said detection device.

In one exemplary embodiment, the detection device is an infrared ray sensor comprising a means for emitting infrared light to form a defined infrared ray detecting zone and a means for detecting infrared light reflected from an object moving into said infrared ray detecting zone. A circuitry responsively generates a message carrying sensing signal having a first voltage with a time length corresponding to the time interval the object entering and staying in said infrared ray detecting zone. When the object leaves the infrared ray detecting zone, the infrared ray sensor delivers a second voltage signal.

In one exemplary embodiment, the detection device is an electrostatic induction sensor comprising a copper sheet sensing unit with adequately designed shape and size to form an electrostatic detecting zone. A circuitry responsively generates a message carrying sensing signal having a first voltage with a time length corresponding to the time interval an inductive object enters and stays in said electrostatic

detecting zone. When said object leaves said electrostatic detecting zone, said electrostatic sensor delivers a second voltage signal.

In one exemplary embodiment, the detection device is a direct touch interface (such as a push button or a touch sensor) connecting with a pin of the microcontroller. When the user contacts the direct touch interface (for example, presses the push button) for a time interval, a first voltage signal is detected by the microcontroller which is a message carrying sensing signal having the first voltage with a time length corresponding to the time interval the touch interface being contacted. When the user leaves the direct touch interface (for example, releases the button), the direct touch interface delivers a second voltage signal.

An exemplary embodiment of the present disclosure provides a lighting apparatus comprising a first lighting load, a second lighting load, a diffuser and a microcontroller based electronic switch. The first lighting load is for emitting light with a first color temperature. The second lighting load is for emitting light with a second color temperature. The diffuser covers the first lighting load and the second lighting load. The microcontroller based electronic switch comprises a first controllable switching element, a second controllable switching element, a detection device and a microcontroller. The first controllable switching element is electrically connected between the first lighting load and a power source. The second controllable switching element is electrically connected between the second lighting load and the power source. The detection device is for detecting an external motion signal played by a user and converting said external motion signal into a message carrying sensing signal. The microcontroller with program codes is written and designed to read and interpret the message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is electrically connected between said second controllable switching element and said detection device. Said microcontroller controls a conduction state or cutoff state of said first controllable switching element and said second controllable switching element according to said message carrying sensing signal generated by said detection device. When the first controllable switching element and second controllable switching element are in the conduction state, said microcontroller further controls electric power transmission levels from the power source to the first lighting load and the second lighting load according to specific format of said message carrying sensing signal received from said detection device. With the microcontroller based electronic switch to control the lighting power levels, the color temperature of the diffused light (also called the blended or mingled light) of the first lighting load and the second lighting load can be controlled.

In one exemplary embodiment, the detection device is an infrared ray sensor comprising a means for emitting infrared light to form a defined infrared ray detecting zone and a means for detecting infrared light reflected from an object moving into said infrared ray detecting zone. A circuitry responsively generates a message carrying sensing signal having a first voltage with a time length corresponding to the time interval the object entering and staying in said infrared ray detecting zone. When the object leaves the infrared ray detecting zone, the infrared ray sensor delivers a second voltage signal.

In one exemplary embodiment, the detection device is an electrostatic induction sensor comprising a copper sheet sensing unit with adequately designed shape and size to form an electrostatic detecting zone. A circuitry responsively generates a message carrying sensing signal having a first voltage with a time length corresponding to the time interval an inductive object enters and stays in said electrostatic detecting zone. When said object leaves said electrostatic detecting zone, said electrostatic sensor delivers a second voltage signal.

In one exemplary embodiment, the detection device is a direct touch interface (such as a push button or a touch sensor) connecting with a pin of the microcontroller. When the user contacts the direct touch interface (for example, presses the push button) for a time interval, a first voltage signal is detected by the microcontroller which is a message carrying sensing signal having the first voltage with a time length corresponding to the time interval the touch interface being contacted. When the user leaves the direct touch interface (for example, releases the button), the direct touch interface delivers a second voltage signal.

To sum up, the present disclosure is characteristic in, a contactless interface between the user and the multifunctional electronic switch is created to implement at least two operation modes of the electronic switch by using software codes written in OTPROM (one-time programmable read only memory) of microcontroller to analyze the message carrying sensing signals.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** is a block diagram of a microcontroller based electronic switch using an infrared ray sensor as a detection device applied for two AC lighting loads with different color temperatures powered by an AC power source according to an exemplary embodiment of the present disclosure.

FIG. **2** is a circuit diagram of a microcontroller based electronic switch using an infrared ray sensor applied for two AC lighting loads with different color temperatures powered by an AC power source according to an exemplary embodiment of the present disclosure.

FIG. **3**A is a schematic diagram showing a practical operation of an infrared ray sensor associated with a microcontroller based electronic switch according to an exemplary embodiment of the present disclosure.

FIG. **3**B is a waveform diagram showing a low voltage sensing signal according to an exemplary embodiment of the present disclosure.

FIG. **4** is a flow chart of a program executed in a microcontroller based electronic switch according to an exemplary embodiment of the present disclosure.

FIG. **5** is a voltage waveform diagram of a microcontroller based electronic switch when the electronic switch operating in the on/off switch control mode is in cut-off state according to an exemplary embodiment of the present disclosure.

FIG. **6** is a voltage waveform diagram of a microcontroller based electronic switch when the electronic switch operating in the on/off switch control mode is in conduction state according to an exemplary embodiment of the present disclosure.

FIG. **7** is a voltage waveform diagram of a microcontroller based electronic switch operating in the dimming control mode according to an exemplary embodiment of the present disclosure.

FIG. **8**A is a block diagram of a microcontroller based electronic switch for a DC power source according to an exemplary embodiment of the present disclosure.

FIG. **8**B is a voltage waveform diagram of the pulse width modulation voltage signals associated with FIG. **8**A according to an exemplary embodiment of the present disclosure.

FIG. **9**A is an application diagram of an exemplary embodiment of the present disclosure for a lighting apparatus.

FIG. **9**B is an application diagram of an exemplary embodiment of the present disclosure for a lighting apparatus.

FIG. **10**A is an application diagram of a traditional popular piece of under cabinet light with LED as light source.

FIG. **10**B is an application diagram of an exemplary embodiment of the present disclosure for a LED under cabinet light featured with a touch-less interface between the user and the under cabinet light.

FIG. **10**C is an application diagram of an exemplary embodiment of the present disclosure for a wall switch construction electrically connected to a ceiling light for the performance of three working modes.

FIG. **10**D is another application diagram of an exemplary embodiment of the present disclosure for a lighting apparatus with a diffuser of hollow body accommodating the lighting loads and the microcontroller based electronic switch.

FIG. **10**E is another application diagram of an exemplary embodiment of the present disclosure for a lighting apparatus with a diffuser of hollow body accommodating the lighting loads and the microcontroller based electronic switch.

FIG. **11**A is another application diagram of an exemplary embodiment of the present disclosure for the direction of motion path detected by an infrared ray sensor.

FIG. **11**B is another application diagram of an exemplary embodiment of the present disclosure for the direction of motion path detected by an infrared ray sensor.

FIG. **11**C is another application diagram of an exemplary embodiment of the present disclosure for the direction of motion path detected by an infrared ray sensor.

FIG. **11**D is another application diagram of an exemplary embodiment of the present disclosure for the direction of motion path detected by an infrared ray sensor.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Reference will now be made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

Referring to FIG. **1**, FIG. **1** is a block diagram of a microcontroller based electronic switch using an infrared ray sensor as a detection device applied for two AC lighting loads with different color temperatures powered by an AC power source according to an exemplary embodiment of the present disclosure. A microcontroller based electronic switch **1** is connected in series to an AC power source **3**, and is further connected to a first lighting load **2***a* (also indicated by "load a" shown in FIG. **1**) and a second lighting load **2***b* (also indicated by "load b" shown in FIG. **1**), so as to control AC power delivered to the first lighting load **2***a* and the second lighting load **2***b*. The microcontroller based electronic switch **1** comprises at least an infrared ray sensor **11**, a microcontroller **12**, a zero-crossing-point detector **13**, and two bi-directional controllable semiconductor switching elements **14***a*, **14***b*. The bi-directional controllable semiconductor switching element **14***a* is a first controllable switching element. The bi-directional controllable semiconductor switching element **14***b* is a second controllable switching element. The infrared ray sensor **11** is connected to one pin of microcontroller **12** to transmit a low voltage sensing signal to the microcontroller **12**, wherein the low voltage sensing signal represents a message carrying sensing signal of the infrared ray sensor **11**. The zero-crossing-point detector **13** is connected to another pin of microcontroller **12** and is also electrically coupled to the AC power source **3** to produce AC power synchronized signals which are fed to the microcontroller **12**. The microcontroller **12** through its one designated pin is electrically connected to the control electrode of the bi-directional controllable semiconductor switching element **14***a* so as using appropriate conduction phase (characterized by tD_a) to control the electrical conduction state of the bi-directional controllable semiconductor switching element **14***a*. Also, the microcontroller **12** through its another one designated pin is electrically connected to the control electrode of the bi-directional controllable semiconductor switching element **14***b* so as using appropriate conduction phase (characterized by tD_b) to control the electrical conduction state of the bi-directional controllable semiconductor switching element **14***b*.

The first lighting load **2***a* is for emitting light with low color temperature (first color temperature), and the second lighting load **2***b* is for emitting light with high color temperature (second color temperature). When the bi-directional controllable semiconductor switching elements **14***a*, **14***b* are in the conduction state, said microcontroller **12** further controls electric power transmission levels from the AC power source **3** to the first lighting load **2***a* and the second lighting load **2***b* according to the signal format of the message carrying sensing signal received from the infrared ray sensor **11**. In this embodiment, the electric power transmission level for the first lighting load **2***a* can range from X-watt to Y-watt, and reversely the electric power transmission level for the second lighting load **2***b* can range from Y-watt to X-watt, where X is a minimum electric power transmitted to the first lighting load or the second lighting load, Y is a minimum electric power transmitted to the first lighting load or the lighting load, and X+Y is a constant value, but the present disclosure is not so restricted. An apparent color temperature generated by blending the lights emitted from the two lighting loads **2***a*,**2***b* may be controlled by the power levels X and Y according to

$$CT_{app}=CT_{2a}\cdot X/(X+Y)+CT_{2b}\cdot Y/(X+Y),$$

where CT_{app} is said apparent color temperature, CT_{2a} and CT_{2b} are respectively the color temperatures of the first and the second lighting load **2***a*, **2***b*.

For example, X-watt can be three watts and Y-watt can be nine watts, such that the power of the first lighting load **2***a* ranges from three watts to nine watts, and the power of the second lighting load **2***b* ranges from nine watts to three

watts, wherein the total power of the first lighting load **2***a* and the second lighting load **2***b* can be fixed to twelve watts. When the color temperatures of the first lighting load **2***a* and the second lighting load **2***b* are respectively 3000K (CT_{2a}) and 5700K (CT_{2b}), the apparent color temperature (CT_{app}) of the blended or diffused light of the first lighting load **2***a* and the second lighting load **2***b* can range nearly from 3700K (nine watts of the first lighting load **2***a* and three watts of the second lighting load **2***b*) to 5000K (three watts of the first lighting load **2***a* and nine watts of the second lighting load **2***b*) depending on the electric power transmission levels fed to the first lighting load **2***a* and the second lighting load **2***b* controlled by the microcontroller **12**.

In another example, X-watt can be zero watts and Y-watt can be twelve watts, such that the power of the first lighting load **2***a* ranges from zero watts to twelve watts, and the power of the second lighting load **2***b* ranges from twelve watts to zero watts, wherein X+Y watt can be fixed to twelve watts. When the color temperatures of the first lighting load **2***a* and the second lighting load **2***b* are respectively 3000K and 5700K, the apparent color temperature of the diffused light of the first lighting load **2***a* and the second lighting load **2***b* can range from 3000K (twelve watts of the first lighting load **2***a* and no power of the second lighting load **2***b*) to 5700K (twelve watts of the second lighting load **2***b* and no power of the first lighting load **2***a*) depending on the electric power transmission levels fed to the first lighting load **2***a* and the second lighting load **2***b*. Thus, a desired color temperature may be generated by controlling the power levels of the first lighting load **2***a* and the second lighting load **2***b* to create proper color blending effect under a fixed total lighting power level with this type of microcontroller based electronic switch.

In still another embodiment, the electric power transmission level for the first lighting load **2***a* can range from X-watt to Y-watt, and the electric power transmission level for the second lighting load **2***b* can range from Z-watt to W-watt, wherein X, Y, Z and W can be referred to different power levels. However, the present disclosure does not restrict the variation ranges of the power levels of the two loads **2***a*, **2***b*.

The infrared ray sensor **11** detects object motions coming from the user and converts the detected result into message carrying low voltage sensing signals readable to the microcontroller **12**. The microcontroller **12** decodes the low voltage sensing signals (message carrying low voltage sensing signals) according to the program designed and written in its OTPROM (one-time programmable read only memory) memory. The microcontroller **12** is with program codes written and designed to read and interpret the message carrying sensing signal generated by the infrared ray sensor **11**. The infrared ray sensor **11** is an exemplary embodiment for a detection device to detect the external motion signal played by the user and convert the external motion signal into a message carrying sensing signal. The microcontroller **12** recognizes the working mode that the user has chosen and proceeds to execute the corresponding loop of subroutine for performing the selected working mode. In view of implementing versatile controls of color temperature and illumination level of a lighting apparatus, at least two working modes are provided and defined in the software codes with corresponding loops of subroutine for execution.

One working mode is on/off switch control mode. In this working mode, according to the low voltage sensing signal from the infrared ray sensor **11**, the microcontroller **12** operates the bi-directional controllable semiconductor switching element **14** in conduction state or cut-off state alternatively. More specifically, in this working mode, together with the zero-crossing-point detector **13**, the microcontroller **12** generates phase delay voltage pulses synchronized with the AC power source **3** in each AC-half cycle to trigger the bi-directional controllable semiconductor switching elements **14***a*, **14***b* to be in proper conduction states to respectively transmit X-watt and Y-watt electric power to the first lighting load **2***a* and the second lighting load **2***b*, such that a fixed amount of total electric power (X+Y watts) is sent to the two lighting loads **2***a*, **2***b*; or the microcontroller **12** generates a zero voltage to set the bi-directional controllable semiconductor switching elements **14***a*, **14***b* to be in cut-off state, and thereby ceases to transmit the fixed electric power to the two lighting loads **2***a*, **2***b*.

Another working mode is switching between low color temperature and high color temperature. When the first switching element is in a full conduction state and the second switching element is in a full cutoff state, the light consequently demonstrates the low color temperature of illumination characteristic. When the first switching element is in the full cutoff state and the second switching element is in the full conduction state, the lighting apparatus consequently demonstrates the high color temperature of illumination characteristic.

Still another working mode is color temperature tuning mode about controlling different levels of electric power transmission to the two lighting loads **2***a*, **2***b* by controlling the conduction rate of the bi-directional controllable semiconductor switching elements **14***a* and **14***b*. Using the synchronized signals produced by the zero-crossing-point detector **13** as a reference, the microcontroller **12** generates phase delay voltage pulses synchronized with the AC power source **3** in each AC half-cycle to trigger the conduction of the bi-directional controllable semiconductor switching elements **14** to respectively transmit X-watt and Y-watt electric power to the first lighting load **2***a* and the second lighting load **2***b*. Responding to the low voltage sensing signals of specific format from the infrared ray sensor **11**, the microcontroller **12** execute the corresponding loop of subroutine for performing the color temperature tuning mode, such that the phase delays of the triggering pulses are continuously changed during each half cycle period of the AC power source **3**, to render the conduction rate of the bi-directional controllable semiconductor switching elements **14***a* gradually increasing and, at the same time, the conduction rate of the bi-directional controllable semiconductor switching elements **14***b* gradually decreasing, or vice versa. Consequently, the power level X of the lighting loads **2***a* is gradually increasing and the power level Y of the lighting loads **2***b* is gradually decreasing, or vice versa. The color temperature of the blended or diffused light of the two lighting load **2***a*, **2***b* may thus be adjusted in the color temperature tuning mode through controlling the conduction rate of the switching elements **14***a*, **14***b* to change the power levels of the two lighting loads **2***a*, **2***b*. At the end of the color temperature tuning mode, a desired apparent color temperature diffused from the two lighting loads **2***a*, **2***b* can be set and managed by the message carrying sensing signal from the infrared ray sensor **11** which is generated according to the user's intention.

For the color temperature tuning mode, additional submodes can be performed in detail. When the detection device generates the first voltage sensing signal, said microcontroller manages to output the control signal to the first controllable switching element and the second controllable switching element to alternately perform one of programmed combinations of conduction states between the first controllable switching element and the second control-

lable switching element, wherein the combinations include at least three combination modes; wherein the first combination mode is where the first controllable switching element is in a complete conduction state while the second controllable switching element is in a cutoff state with the lighting apparatus performing the low color temperature, wherein the second combination mode is where the first controllable switching element is in a cutoff state while the second controllable switching element is in a complete conduction state with the lighting apparatus performing the high color temperature, wherein the third combination mode is where both the first controllable switching element and the second controllable switching element are in cutoff state with the lighting apparatus being turned off.

Referring to FIG. **1** and FIG. **2**, FIG. **2** is a circuit diagram of a microcontroller based electronic switch applied for an AC power source according to an exemplary embodiment of the present disclosure.

As FIG. **2** shows, the microcontroller based electronic switch **1** comprises an infrared ray sensor **11**, a microcontroller **12**, a zero-crossing-point detector **13**, and two bi-directional controllable semiconductor switching elements **14***a*, **14***b*. The microcontroller based electronic switch **1** is connected respectively through the bi-directional controllable semiconductor switching elements **14***a*, **14***b* with the first lighting load **2***a* and the second lighting load **2***b*, both have different color temperatures, and then connected to the AC power source **3** in a serial fashion. A DC voltage VDD for the circuit system is derived by conventional voltage reduction and rectification from the AC power **3**. The infrared ray sensor **11** is composed of a transmitting circuit **110** and a receiving circuit **112**, wherein the message carrying sensing signal is sent out by a transistor stage M**2**. The drain of the transistor M**2** is connected to a pin pin_**3** of the microcontroller **12** to deliver the message carrying sensing signals to the microcontroller **12**.

The zero-crossing-point detector **13** is composed of a transistor Q**1** and a diode D**3**. The collector of the transistor Q**1** is connected to a pin pin_**10** of the microcontroller **12**, the base of the transistor Q**1** is connected to a conducting wire of the AC power source **3** through the diode D**3** and a resistor R**3**. In the positive half-cycle for AC power source **3**, the transistor Q**1** is saturated conducting, and the voltage at the collector of the transistor Q**1** is close to zero. In the negative half-cycle for AC power source **3**, the transistor Q**1** is cut-off, and the voltage at the collector of the transistor Q**1** is a high voltage of VDD. Corresponding to the sine wave of the AC power source **3**, the zero-crossing-point detector **13** generates therefore signals of square wave alternatively with a low voltage and a high voltage through the collector of the transistor Q**1**. The square wave is synchronized with the AC power source **3** and sent to a pin pin_**10** of the microcontroller **12** for the purpose of controlling conduction phase, and the details thereof are described later. In practice, the bi-directional controllable semiconductor switching element **14***a* can be a triac T**1***a*, the pin pin_**1** of the microcontroller **12** is connected to the gate of the triac T**1***a* to control the conduction or cut-off state of the triac T**1***a*, or to control the conduction rate of the triac T**1***a*. Also, the bi-directional controllable semiconductor switching element **14***b* can be a triac T**1***b*, the pin pin_**2** of the microcontroller **12** is connected to the gate of the triac T**1***b* to control the conduction or cut-off state of the triac T**1***b*, or to control the conduction rate of the triac T**1***b*. Thus, the first lighting load **2***a* and the second lighting load **2***b* are respectively driven by triac T**1***a* and triac T**1***b* with phase delay pulses characterized by time delays tD_a and tD_b with respect to the zero

crossing point of AC power voltage in each AC half-cycle to respectively display X-watt (or Y-watt) lighting from the first lighting load **2***a* and Y-watt (or X-watt) power lighting from the second lighting load **2***b* controlled by infrared ray sensor **11**. Thus, the color temperature of the diffused light of the two lighting load **2***a*, **2***b* may be adjusted by properly selecting tD_a and tD_b, such that the summation of tD_a and tD_b is a constant, and the total lighting power of the first lighting load **2***a* (X) and the second lighting load **2***b* (Y), X+Y, is a fixed value.

Still referring to FIG. **2**, the infrared ray sensor **11** comprises a transmitting circuit and a receiving circuit. In the transmitting circuit, an infrared light-emitting diode IR_LED is connected to the drain of the transistor M**1** in a serial fashion, and the gate of the transistor M**1** is connected to an output of the timer **110**. In practice, the timer **110** can be a 555 timer IC. The 555 timer IC generates a square-wave with a frequency of about 3 kHz to modulate the drain current of the transistor M**1**, such that the infrared light-emitting diode IR_LED provides an infrared light signal with a square wave form which is severed as the light source of the infrared ray sensor.

The receiving circuit is an infrared light detection circuit and comprises a photosensitive diode PD, two serially connected amplifiers **112**, **114**, and a transistor M**2**. The drain of the transistor M**2** is connected to a pin pin_**3** of the microcontroller **12**. In practice, the amplifiers **112** and **114** can be LM324 operational amplifier. The combination of the amplifier **114** and resistors R**7** through R**10** is a Schmitt trigger circuit having a threshold voltage, and the threshold voltage is produced by the voltage divider composed by resistors R**8** and R**9**. The Schmitt trigger circuit makes possible a high discrimination of a true detection to a false one.

The photosensitive diode PD is used to receive the infrared light signal from the transmitting circuit. If the output voltage of the amplifier **112** exceeds the threshold voltage, the amplifier **114** produces a high voltage applied to the gate of the transistor M**2**, such that the transistor M**2** is turned on. Therefore, the drain of the transistor M**2** provides a low voltage sensing signal which is close to zero voltage, and the time length of the low voltage sensing signal is related to the time period the infrared ray is detected.

In addition, if the photosensitive diode PD does not receive the infrared light signal, the output voltage of the amplifier **112** is lower than the threshold voltage, and then the amplifier **114** provides a low voltage to the gate of the transistor M**2**, such that the transistor M**2** is turned off. Therefore, the drain of the transistor M**2** provides a high voltage of VDD. In other words, the pin pin_**3** of the microcontroller **12** receives either a low voltage sensing signal or a high voltage depending on whether the infrared ray sensor **11** detects the infrared light or not, wherein the time length of the low voltage sensing signal is about the time period within which the infrared light is detected.

In other words, the infrared ray sensor **11** generates a sensing signal which is characterized by a low voltage within a time length. The sensing signal with a specific time length of low voltage can be considered as a sensing signal format which carries message to make the microcontroller **12** to operate in one of at least two working modes accordingly, wherein one working mode is on/off switch control mode and the another one is color temperature tuning mode to control the conduction rate of the bi-directional controllable semiconductor switching elements **14***a* and **14***b*. Further, still another mode is dimming control mode. The color temperature tuning mode can give a color temperature

tuning cycle to change the color temperature of the blended light, wherein the total power of the blended light is unchanged (X+Y watts is unchanged during the cycle). The dimming control mode provides dimming cycles to set the total power of the blended light (X+Y watts is changed during the cycle), wherein the color temperature of the blended light is unchanged during the dimming cycle.

Referring to FIG. **2**, FIG. **3**A and FIG. **3**B, FIG. **3**A is a schematic diagram showing a practical operation of an infrared ray sensor associated with a microcontroller based electronic switch according to an exemplary embodiment of the present disclosure, and FIG. **3**B is a waveform diagram showing a low voltage sensing signal according to an exemplary embodiment of the present disclosure. In FIG. **3**A, the infrared light-emitting diode IR_LED is parallel arranged to the photosensitive diode PD without accurate alignment. When an object, here is a human hand, moves in front of the infrared light-emitting diode IR_LED, the infrared light emitted from the infrared light-emitting diode IR_LED scatters from the object surface onto the photo sensing surface of the photosensitive diode PD.

FIG. **3**B shows a waveform of the low voltage sensing signal provided from the infrared ray sensor **11**. If the photosensitive diode PD does not receive the infrared light scattered from the target object surface, or the intensity of the infrared light received by the photosensitive diode PD is insufficient, the drain of the transistor M**2** provides a high voltage H of VDD. Within an appropriate distance, the photosensitive diode PD receives the infrared light scattered from the object surface, and the intensity of the received infrared light is enough to cause the output voltage of the amplifier **112** exceeding the threshold voltage, the amplifier **114** produces a high voltage, such that the transistor M**2** is turned on, and the drain of the transistor M**2** provides a signal with a low voltage L of about zero volt. In other words, when the infrared ray sensor **11** detects an object, most commonly user's hand, purposefully entering the infrared ray detecting zone, the infrared ray sensor **11** generates a low voltage sensing signal, by contrast when an object is not within the infrared ray detecting zone, the infrared ray sensor **11** generates a high voltage. In brief, the infrared ray sensor **11** comprises a means for emitting infrared light to form the defined infrared ray detecting zone, and a means for detecting infrared light reflected from the object moving into the infrared ray detecting zone.

The appropriate distance or the infrared ray detecting zone is defined as an effective sensing range or area of the infrared ray sensor **11**. In FIG. **3**B, the time length Ts of the low voltage L is approximately equal to the time period that an object stays within the infrared ray detecting zone, wherein the time period is about a few tenths through a few seconds. When the object leaves the infrared ray detecting zone, the signal delivered from the infrared ray sensor **11** changes from a low voltage L to a high voltage H, as shown in FIG. **3**B. Hence the sensing signal generated from the infrared ray sensor **11** is a binary signal readable to the program written in the OTPROM memory of the microcontroller **12**. The microcontroller based electronic switch **1** utilizes specific sensing signal format characterized by the time length Ts of the low voltage sensing signal to implement at least two functions, namely, on/off switch control and dimming control. By introducing a preset time To, the microcontroller **12** can execute subroutine corresponding to the functions of the on/off switch control, the color temperature tuning control and the illumination power dimming control determined by a comparison scheme of the time length Ts with the preset time To. The user can therefore operates the microcontroller-based electronic switch **1** in a convenient manner simply by moving his hand into or out of the infrared ray detecting zone of the infrared ray sensor **11**, and staying his hand there for a time period to select desired performance function.

Referring to FIG. **2**, FIG. **3** and FIG. **4**, FIG. **4** is a flow chart of a program executed in a microcontroller of a microcontroller based electronic switch according to an exemplary embodiment of the present disclosure. The program written in the OTPROM memory of the microcontroller **12** includes several subroutine loops. These loops are started from the loop of steps S**1** through S**6** of the on/off switch control mode, and may jump into the loop of steps S**8** through S**10** of the color temperature tuning mode (or the dimming control mode) according to the time length Ts of the low voltage sensing signal. The pin pin_**3** of the microcontroller **12** receives a high voltage H or a low voltage L from the infrared ray sensor **11**, wherein the time length Ts of the low voltage sensing signal is about the time length which the user's hand stays within the infrared ray detecting zone.

The program of the microcontroller **12** starts its execution from the loop of steps S**1** and S**2** in which the microcontroller based electronic switch **1** is off. The program of the microcontroller **12** scans the voltage at the pin pin_**3** of the microcontroller **12**. If the voltage at the pin pin_**3** of the microcontroller **12** is high (bit **1**), the program of the microcontroller **12** stays in the loop of steps S**1** and S**2** that the microcontroller based electronic switch **1** is off. On the contrary, if the voltage at the pin pin_**3** is low (bit **0**), the program of the microcontroller **12** jumps into the loop of steps S**3** through S**6** in which the microcontroller based electronic switch **1** is on. At step S**4** when the microcontroller based electronic switch **1** is on, the program of the microcontroller **12** scans the voltage at the pin pin_**3** of the microcontroller **12**. If the voltage at the pin pin_**3** of the microcontroller **12** is low (bit **0**), the program of the microcontroller **12** jumps to step S**5** to compare the time length Ts with a preset time To. In practice, the preset time To is between 1 through 3 seconds, but the present disclosure is not limited thereto.

At step S**5**, the program of the microcontroller **12** check the time length Ts, if Ts is shorter than the preset time To, step S**5** proceeds to step S**6** to detect whether the voltage at the pin pin_**3** is momentary a high voltage H (bit **1**). At step S**6**, if the voltage at the pin pin_**3** is the voltage H, the program goes back to the loop of steps S**1** and S**2** in which the microcontroller based electronic switch **1** is off. At step S**6**, if the voltage at the pin pin_**3** is low, the program remains in the loop of steps S**3** through S**6** in which the microcontroller based electronic switch **1** is on.

To sum up, the on/off switch control mode is described by the loops consisting of steps S**1** through S**6** that the microcontroller based electronic switch **1** is operated in off- and on-state rotationally. The microcontroller based electronic switch **1** is on or off according to whether the user moves his hand into and then pulls out the infrared ray detecting zone of the infrared ray sensor **11** within the preset time To.

At step S**5**, the program of the microcontroller **12** check the time length Ts, if the time length Ts is longer than the preset time To, the program jumps to step S**7** to detect whether the time length Ts is longer than n times the preset time To (n≥2). At step S**7**, if the time length Ts is not longer than n times the preset time To, the program goes back to the loop of steps S**3** through S**6** that the microcontroller based electronic switch **1** remains on. At step S**7**, if the time length Ts is longer than n times the preset time To, the program

jumps into a loop consisting of steps S**8** through S**10** to execute a subroutine for the color temperature tuning mode (or the dimming control mode) of microcontroller based electronic switch **1**. FIG. **4** does not show the details of subroutine associated with the color temperature tuning mode (or the dimming control mode), but the process is described in short as follows. At step **9**, the program of the microcontroller **12** scans the voltage at the pin pin_**3** of the microcontroller **12**. The program proceeds to step **10** from Step **9**, if the voltage at the pin pin_**3** is low. At step **10**, the subroutine of the microcontroller **12** checks if Ts>nTo. If the voltage at the pin pin_**3** is low for several times, and the time lengths denoted by Ts or Ts' are shorter than n times the preset time To, the subroutine remains in the rotation loop defined by step **8** through S**10**, and microcontroller **12** continuously increases or decreases the electric power transmission to the lighting loads **2***a*, **2***b* by controlling the conduction rates. If the electric power of the lighting load reaches the maximum or minimum electric power, the program of the microcontroller **12** responds no more to the low voltage sensing signal. At step **10**, if the time length Ts is longer than n times the preset time To, the program of the microcontroller **12** jumps back to the loop of steps S**1** and S**2** in which the microcontroller based electronic switch **1** is off. Then, the program of the microcontroller **12** resumes itself from steps S**1** and S**2** in a rotational manner to execute the subroutines represented by the steps shown in FIG. **4**.

In the exemplary embodiment of FIG. **2**, the preset time To and the number n can be set 2 seconds and 2, respectively. Referring to the steps executed by the microcontroller **12** in FIG. **4**, if the detected time length Ts of the low voltage sensing signal at the pin pin_**3** is less than 2 seconds, that means the time period which the hand stays within the infrared ray detecting zone is less than 2 seconds, the microcontroller **12** remains in the current function mode. If the detected time length Ts at the pin pin_**3** is longer than 4 seconds, that means the time length which the hand stays within the infrared ray detecting zone is longer than 4 seconds, the microcontroller **12** changes the current function mode to another one function mode. In other words, if the time length Ts of the low voltage sensing signal is shorter than the preset time To, the microcontroller **12** operates either in on/off switch control mode or in color temperature tuning mode (or dimming control mode). If the detected time length Ts of the low voltage sensing signal is longer than n times the preset time To, the microcontroller **12** changes its program execution from the on/off switch control mode into the color temperature tuning mode (or the dimming control mode) and vice versa.

In another embodiment, the concept of the present disclosure can be further extended to implement a multifunctional electronic switch having at least three functions built in one, which are on/off switch control, illumination dimming control and color temperature management. The program written in the OTPROM memory of the microcontroller can be modified in such a manner that the microcontroller responds not only to the low voltage sensing signal of the infrared ray sensor, but also to a specific sequence of the sensing signals. The microcontroller executes subroutines of working modes corresponding to the said three functions according to the detected time length Ts and special sequence of the low voltage sensing signals. The first working mode is on/off switch control mode used to control the conduction or cut-off state of the controllable semiconductor switching elements. The second working mode is dimming control mode used to control the conduction rates of the controllable semiconductor switching elements. The third working mode is color temperature management mode used to change alternatively from a high color temperature to a low one, or vice versa, or to tune the color temperature of the diffused light from two lighting loads. When the infrared ray sensor generates a low voltage sensing signal within the preset time To, the microcontroller operates in the on/off switch control mode by controlling the conduction or cut-off state of both the controllable semiconductor switching elements alternately. If the time length Ts of the low voltage sensing signal is longer than n times the preset time To, the microcontroller changes its operation from the on/off switch control mode to the color temperature tuning or dimming control mode. Once in the dimming (tuning) control mode, the microcontroller executes subroutine to gradually change the conduction rates of the controllable semiconductor switching elements from the maximum conduction rate to the minimum conduction rate, and then to gradually change the conduction rate from the minimum conduction rate to the maximum conduction rate for completing a dimming cycle wherein the process is a free run. In the dimming cycle with free run, the moment when the infrared ray sensor provides a high voltage is a dimming end point. According to the dimming control mode design, the microcontroller locks the conduction rates of the controllable semiconductor switching elements at the dimming end point. Thereafter, if the infrared ray sensor generates a plurality of low voltage sensing signals, for instance, a plural signal of two consecutive sensing signals, each within the preset time To, the microcontroller operates in the color temperature management mode by executing a subroutine to select a color temperature of the diffused light from two lighting loads through controlling different power levels delivered to the two lighting loads of different color temperatures. It is clear to see the advantage of the present disclosure to integrate various switch control functions in one without changing the hardware circuit design. All are simply done by defining the format of sensing signals and by modifying the program written in the OTPROM memory in the microcontroller.

As mentioned above, various switch control functions can be integrated in one without changing the hardware circuit design of the microcontroller and the two loads. There may be variations of detection device in using electronic switch of the present disclosure for touch and touch less applications. For example, (1) Dual detection device technology in which two detection device are integrated in one electronic switch, for instance, by connecting two infrared ray sensors respectively with two pins of the microcontroller **12** in FIG. **1**, to control a lighting apparatus: one first detection device sending message carrying sensing signal to control the color temperature of illumination characteristic, one second detection device sending message carrying sensing signal to control the light intensity of illumination characteristic; (2) Single detection device technology in which one detection device is built in an electronic switch to generate message carrying sensing signal to control a lighting apparatus by using different types of signal formats: a first type sensing signal (for instance, a low voltage within a short preset time To) to control the on/off performance, a second type sensing signal (for instance, a low voltage with a long time length Ts) to control the switching between low color temperature mode and high color temperature mode, and a third type sensing signal (for instance, a plural signals of two consecutive low voltages) for dimming the light intensity of illumination characteristic; (3) Single detection device technology using free running technique in response to a specific format sensing signal to offer selection of color temperature.

The free running subroutine can be designed to apply to an electronic switch installed on wall for managing the illumination characteristics of a remotely located lighting apparatus such as a ceiling light installed on the ceiling. Unless a wireless communication unit is employed, a typical wall switch is constrained by a single circuit to only perform one illumination characteristic, being either controlling the light intensity or controlling the color temperature. If both the color temperature and light intensity are required to manage, the only way is to use the free running technology to execute one of the two illumination characteristics. The free running subroutine can be so deigned such that whenever a power supply is on, the microcontroller with software subroutine will check the memory unit to see if a preset color temperature or light intensity is established to decide if the free running subroutine needs to be activated, in the absence of preset datum, a free running action will be activated to gradually change the lighting intensity from maximum intensity to minimum intensity and continuously from minimum intensity to maximum intensity for completing a tuning/dimming cycle on an automatic basis and at any moment during a tuning/dimming cycle the user can determine the light intensity by acting a motion signal to lock in the level of the light intensity. The automatic tuning/dimming only continues for a short duration and in the absence of selection by the user, the microcontroller with program codes will execute a predetermined lighting intensity. Similarly, the same mechanism can be applied for tuning the color temperature to allow the user to select the desired color temperature during a free tuning cycle by acting a motion signal with the detection device to lock in the desired level of color temperature. With the help of free running technology, the wall control unit can therefore be used solely for operating the remaining illumination characteristic.

The concept of free running technology can be further applied to develop a life style LED lighting solution where the color temperature is gradually changed according to time schedule programmed for performing different color temperature catering to the living style of human beings that people are more used to low color temperature with a warm atmosphere during the night time from 7 PM through 5 PM while during the day time people are more used to the high color temperature for working hours. A clock can be employed to provide the time information necessary for working with a program of scheduled color temperature pattern. The conduction rate **r1** of the first controllable switching element can be varied in a reverse direction with respect to the conduction rate **r2** of the second controllable switching element, the microcontroller with program codes executes to vary the conduction rate of the first controllable switching element according to a programmed pattern of color temperature changes in a subroutine; when **r1** is equal to zero, the first controllable switching element is in a cutoff state while the second controllable switching element is in a full conduction state, the lighting apparatus performs a low color temperature, 3000K for instance, which may be the desired color temperature for the night time from 7 PM to 5 PM, when **r1** is maximum, the first controllable switching element is in a full conduction state while the second controllable switching element is in a cut off state, the lighting apparatus performs a high color temperature, 5000K for instance, which may be the desired color temperature for noon time at 12 PM. A single color temperature may be assigned for night period from 7 PM through 5 AM for the sleeping time. For day time it can be programmed to gradually change the values of **r1** and **r2** from maximum to 0 between 5 AM to 12 PM and from 0 to maximum between 12 PM to 7 PM. With such arrangement at any time when the power is turned on the lighting apparatus automatically performs a desired color temperature according to the programmed pattern of color temperature at scheduled time frame.

Refer to FIG. **5**, FIG. **6** and FIG. **7** in accompanying FIG. **2** and FIG. **4**. According to an exemplary embodiment of the present disclosure, FIG. **5** is a voltage waveform diagram of a microcontroller based electronic switch in cut-off state when operating in on/off switch control mode, FIG. **6** is a voltage waveform diagram of a microcontroller based electronic switch in conduction state when operating in on/off switch control mode, and FIG. **7** is a voltage waveform diagram of a microcontroller based electronic switch when operating in dimming control mode. In FIG. **5**, FIG. **6**, and FIG. **7**, the voltage waveforms as shown from the top are, respectively, a sine wave output from the AC power source **3**, an output signal of the zero-crossing-point detector **13** that is fed to pin pin_**10** of the microcontroller **12**, an output signal from the pin pin_**1** of the microcontroller **12**, and a voltage waveform between the two ends of the load **2**_a_. The voltage waveforms are used to describe the interactions related to the program of the microcontroller **12** and the microcontroller based electronic switch **1** in the above mentioned two working modes. As already described above, the voltage signal generated by the zero-crossing-point detector **13** is a square wave with a low and a high voltage, which is fed to the pin pin_**10** of the microcontroller **12** and, to be explained later, served as an external interrupt trigger signal. The voltage signal from the pin pin_**1** of the microcontroller **12** is sent to the gate of the triac T**1**_a_ to control the conduction state of the triac T**1**_a_. In the same way, the similar voltage signal from the pin pin_**2** of the microcontroller **12** is sent to the gate of the triac T**1**_b_ to control the conduction state of the triac T**1**_b_.

In the program loops corresponding to the on/off switch control mode and the dimming control mode, the microcontroller **12** utilizes the external interrupt control technique to generate voltage pulses synchronized with AC power. To accomplish it, the program of the microcontroller **12** has a setup with the voltage level variations at the pin pin_**10** as external interrupt trigger signals. Since the time point of high or low voltage level variation in the signal generated by the zero-crossing-point detector **13** is the zero crossing point of AC sine wave, the external interrupt process is automatically triggered at the zero crossing point of the AC power source **3**, and the related meaning of the details are further described in FIG. **6** and FIG. **7**.

Referring to FIG. **5** in accompanying FIG. **2** and FIG. **4**, the program of the microcontroller **12** starts from the loop of steps S**1** and S**2** of on/off switch control mode, wherein the microcontroller based electronic switch **1** is off. The program of the microcontroller **12** scans the voltage at the pin pin_**3**. If the voltage at the pin pin_**3** is a high voltage, the microcontroller **12** generates a zero voltage at the pin pin_**1**, which is fed to the gate of the triac T**1**_a_ to turn it off. For no current flowing through the triac T**1**_a_, the voltage between the two ends of the load **2**_a_ is zero in each AC cycle. In the same way, if the voltage at the pin pin_**3** is a high voltage, the microcontroller **12** generates a zero voltage at the pin pin_**2**, which is fed to the gate of the triac T**1**_b_ to turn it off.

Refer to FIG. **6** in accompanying FIG. **2** and FIG. **4**. If the program of the microcontroller **12** detects a low voltage at the pin pin_**3**, the program of microcontroller **12** jumps to steps S**3** and S**4** of on/off switch control mode, wherein the microcontroller based electronic switch **1** is on. The microcontroller **12** scans within a few microseconds the voltage at

the pin pin_**10**. The external interrupt happens in each AC half cycle (of some milliseconds) at the time point of voltage level variation in the square wave signal. In the external interrupt process, no other program is executed, instead the program is commanded to go back to the main program instantly. The program of the microcontroller **12** is designed based on the time point when the external interrupt occurs, which is also the zero crossing point of the AC power source **3**. After some delay times with respected to the time point of the external interrupt, the program of the microcontroller **12** generates a pulse signal at the pin pin_**1** and a pulse signal at the pin pin_**2**. The signal provided from the pin pin_**1** is a zero-crossing-point time-delay pulse having a delay time tD_a after the zero crossing point of AC power. The signal provided from the pin pin_**2** is a zero-crossing-point time-delay pulse tD_b having a delay time tD_b after the zero crossing point of AC power. The zero-crossing-point time-delay pulse tD_a (or tD_b) is generated both in the positive and negative half-cycle of the AC power source **3**, and used to trigger in synchronization with AC power source **3** the triac T**1***a* (or triac T**1***b*) into conduction, such that the AC power source **3** delivers in each half AC cycle electric power to the first lighting load **2***a* (or the second lighting load **2***b*) which is in proportion to a conduction time ton_a of the triac T**1***a* (or ton_b of triac T**1***b*). In contrast with the AC power source **3** and the zero crossing point delay pulses, the voltage waveform on the first lighting load **2***a* is depicted in FIG. **6**, and the conduction time ton_a is designated. The voltage waveform on the second lighting load **2***b* can be similar to the voltage waveform on the first lighting load **2***a*, wherein the conduction time ton_b of triac T**1***b* can be different from the conduction time ton_a of the triac T**1***a* which are respectively resulted from different delay time tD_b and delay time tD_a of the zero-crossing-point time-delay pulses.

In the loop of steps S**3** and S**4** of the microcontroller based electronic switch **1** being on, the delay times tD_a and tD_b of the zero-crossing delay voltage pulses are both predetermined values to make a constant average electric power delivered to the loads **2***a*, **2***b*. The color temperature of the diffused light of the two lighting load **2***a*, **2***b* may be controlled by properly selecting tD_a and tD_b, such that the summation of tD_a and tD_b is a constant, and the total lighting power of the first lighting load **2***a* (X) and the second lighting load **2***b* (Y), X+Y, is a fixed value. However, it is not to limit thereto in the present disclosure. By designing a minimum time delay, summation of the conduction time ton_a and ton_b of the triac T**1***a* and the triac T**1***b* can reach the maximum to make the maximum electric power transmission to the loads **2***a*, **2***b*. In practice, the loads **2***a*, **2***b* can be fluorescent lamps, AC LEDs (light emitting diode) screwed-in LED bulbs or incandescent bulbs, wherein said light-emitting diode module comprises a full-wave rectifier bridge and a plurality of light-emitting diodes in series connected between the two terminals of the rectifier bridge output port. Alternatively, the two loads **2***a*, **2***b* can be DC LED modules power by a DC source.

Refer to FIG. **7** in accompanying FIG. **2** and FIG. **4**. In the loop of steps S**3** through S**6**, the microcontroller based electronic switch **1** is on, the program of the microcontroller **12** scans the voltage at the pin pin_**3**. If the sensing signal fed to the pin pin_**3** is a low voltage with the time length Ts longer than nTo (n≥2), the program of the microcontroller **12** jumps to the loop of steps S**8** through S**10** for executing the color temperature tuning mode. When the microcontroller based electronic switch **1** is in the color temperature tuning mode, the program of the microcontroller **12** scans the voltage at the pin pin_**10**, so as to generate a zero-crossing-point time-delay pulse with a delay time tD_a at the pin pin_**1** and to generate a zero-crossing-point time-delay pulse with a delay time tD_b at the pin pin_**2**. Simultaneously, the program of the microcontroller **12** scans the voltage at the pin pin_**3**. If the detected sensing voltage at the pin pin_**3** is a low voltage with different time length Ts, the program continuously increases the delay time tD_a and decreases the delay time tD_b, or vice versa, of the zero-crossing-point time-delay pulses generated respectively at the pin pin_**1** and pin pin_**2**, wherein the varying time length tD_a and tD_b are in proportion to the time length Ts. It should be noted that both delay times tD_a and tD_b vary in an appropriate range from "t_o" to "$1/(2f)-t_o$", wherein $t_o=(\frac{1}{2}\pi f)\sin^{-1}(V_t/V_m)$, f is the AC frequency, V_t is the threshold voltage or cut-in voltage of the lighting loads **2***a*, **2***b* and V_m is the voltage amplitude of the AC power source **3**. This constraint on tD_a and tD_b is required to ensure in each AC half-cycle to stably trigger the triac T**1***a* and triac T**1***b* into conduction when the threshold voltage V_m of the lighting loads **2***a*, **2***b* are taken into consideration. FIG. **7** shows for one case the waveforms in the color temperature tuning mode wherein the delay time tD_a of the time delay pulse at the pin pin_**1** is gradually increased along the time axis. The delay time tD_a decides the time length of the conduction time ton_a of triac T**1***a*. The average electric power delivered to the first lighting load **2***a*, which is in proportion to the time length ton_a, is accordingly decreased. At the same time for the same case, not shown in FIG. **7**, the delay time tD_b of the time delay pulse at the pin pin_**2** is gradually decreased in the reverse direction, the conduction time ton_b of triac T**1***b* and the average electric power delivered to the second lighting load **2***b* are thus accordingly increased. Consequently, the color temperature of the diffused light of the two lighting load **2***a*, **2***b* may vary gradually from a high temperature to a low one, or vice versa, due to alternatively changing the power levels of the two lighting load **2***a*, **2***b* controlled by the trigger pulses with delay times tD_a and tD_b. When the voltage at the pin pin_**3** becomes high to terminate the color temperature tuning mode, the final values of the delay times tD_a and tD_b are then stored in the memory of the microcontroller **12** as new predetermined values to perform illumination with a desired color temperature and power level.

In addition, the concept of the present disclosure can also be applied to the DC power source, wherein the controllable semiconductor switching element and the program of the microcontroller **12** should be modified slightly, and the zero-crossing-point detector should be removed. Referring to FIG. **8**A, FIG. **8**A is a block diagram of a microcontroller based electronic switch **1'** using an infrared ray sensor as a detection device for a DC power source according to an exemplary embodiment of the present disclosure. The microcontroller based electronic switch **1'** is connected to a DC power source **3'** and a first lighting load **2'***a* in a serial fashion, so as to control the electric power of the DC power source **3'** delivered to the first lighting load **2'***a*. Also, the microcontroller based electronic switch **1'** is connected to the DC power source **3'** and a second lighting load **2'***b* in a serial fashion, so as to control the electric power of the DC power source **3'** delivered to the second lighting load **2'***b*. Compared to FIG. **1**, the microcontroller based electronic switch **1'** in FIG. **8**A comprises an infrared ray sensor **11'**, a microcontroller **12'**, and uni-directional controllable semiconductor switching elements **14'***a*, **14'***b*. In practice, the uni-directional controllable semiconductor switching elements **14'***a*, **14'***b* can be bipolar junction transistors (BJTs) or

metal-oxide-semiconductor field-effect transistors (MOSFETs). The loads **2'**a and **2'**b can respectively emit low color temperature light and high color temperature light. The load **2'**a and **2'**b can be light-emitting diodes or incandescent bulbs, but present disclosure is not limited thereto.

Referring to FIG. **3** and FIG. **8**B, the infrared ray sensor **11'** detects a user's hand, for instance, and converts the outcome into message carrying low voltage sensing signals readable to the microcontroller **12'**. The microcontroller **12'** decodes the low voltage sensing signal according to the program designed and written in its OTPROM, so as to make the microcontroller based electronic switch **1'** operate in on/off switch control mode and color temperature tuning mode (or dimming control mode) accordingly. In the on/off switch control mode when the microcontroller based electronic switch **1'** is off, the program of the microcontroller **12'** generates a zero voltage fed to the gate of the uni-directional controllable semiconductor switching element **14'**a (or **14'**b) so as to turn off the switching element **14'**a (or **14'**b). In the on/off switch control mode when the microcontroller based electronic switch **1'** is on, the program of the microcontroller **12'** generates PWM_a (pulse-width-modulation) (or PWM_b) signal fed to the gate of the uni-directional controllable semiconductor switching element **14'**a (or **14'**b) so as to turn on the switching element **14'**a (or **14'**b) such that a fixed electric power is transmitted from the DC power source **3'** to the load **2'**a (or **2'**b).

FIG. **8**B is a voltage waveform diagram of the PWM signals according to an exemplary embodiment of the present disclosure. The PWM voltage signal is a square wave signal comprising a zero voltage (or low-voltage) and a high voltage, wherein the high voltage drives the uni-directional controllable semiconductor switching element **14'**a (or **14'**b) into conduction. If the time length of the high voltage is T_{2a} (or T_{2b}) and the period of the PWM voltage signal is T_1, the average electric power delivered to the load **2'**a (or **2'**b) through the uni-directional controllable semiconductor switching element **14'**a (or **14'**b) is proportional to the ratio T_{2a}/T_1 (or T_{2b}/T_1), which is by definition the duty cycle of the PWM voltage signal and is denoted as $\delta=T_{2a}/T_1$ (or $\delta=T_{2b}/T_1$).

More specifically, the electronic switch **1'** controls on/off and dimming of the first lighting load **2'**a and the second lighting load **2'**b in response to the operation of the infrared ray sensor **11'**. When the switch **1'** is turned on, the microcontroller **12'** sends PWM voltage signals PWM_a and PWM_b for FIG. **8**A controlled by the infrared ray sensor **11'**: as shown, it is always to generates voltage signals PWM_a and PWM_b with two predetermined time lengths of T_{2a} and T_{2b}, wherein $T_{2a}+T_{2b}=T_1$ for respectively controlling the load **2**a to generate X watts power illumination and the load **2**b to generate Y watts power illumination, where the summation X+Y is a fixed value. It may be $T_{2a}<T_{2b}$ or $T_{2a}>T_{2b}$ in response to the control signal generated by infrared ray sensor **11'**. In a free running mode for color temperature tuning in response to the control signal generated by infrared ray sensor **11'**, T_{2a} may be varied gradually from a large value to a small one while T_{2b} varied gradually from a small value to a large one, and vice versa, wherein $T_{2a}+T_{2b}=T_1$. A color temperature generated by blending the lights emitted from the lighting load **2'**a and **2'**b can thus be selected when the free running mode for color temperature tuning is terminated by moving object (for example, the user's hand) out of the detecting zone of the infrared ray sensor **11'**, and then the final values of T_{2a} and T_{2b} would be stored in the memory of the microcontroller **11'**.

The present disclosure is not limited by the PWM waveforms as depicted in FIG. **8**B. In a practical design scheme, the parameters T_{2a} and T_{2b} of the PWM voltage signals can have a relation $T_{2a}+T_{2b}=A$, wherein "A" is a predetermined constant. Since the average electric powers delivered to the lighting loads **2'**a and **2'**b are respectively proportional to the duty cycles T_{2a}/T_1 and T_{2b}/T_1, both are smaller than one, the total average lighting power is in proportion to the summation of T_{2a}/T_1 and T_{2b}/T_1. When the voltage signals PWM_a and PWM_b are designed with A>T**1**, the color temperature of the diffused light of the two lighting load **2**a, **2**b can be generated under a total average lighting power larger than the one when A=T**1**. With A<T**1**, the total average lighting power is smaller than the one when A=T**1**. Thus, besides the color temperature tuning, the illumination power level may be controlled through varying the parameter A in a predetermined range by the microcontroller based electronic switch **1'** of the present disclosure.

The aforementioned microcontroller-based electronic switch can have many functions, such as on/off switch control, dimming control and color temperature tuning or management control, that are integrated in one without additional hardware complexity. This multifunctional electronic switch can be applied to a lighting apparatus. Please refer to FIG. **9**A, a lighting apparatus having the microcontroller-based multifunctional electronic switch is provided. The lighting apparatus comprises a base **91**a, a first lighting load **92**a, a second lighting load **93**a, a diffuser **94**a and a microcontroller based electronic switch (not shown in the figure). The base **91**a is for disposing the first lighting load **92**a, the second lighting load **93**a and the microcontroller based electronic switch which has been described in previous embodiments. The operation of the microcontroller based electronic switch related to lighting characteristic control of the first lighting load **92**a and the second lighting load **93**a can be referred to previous embodiments, thus the redundant information is not repeated. For diffusing or spreading out or scattering the different color temperature light emitted by the first lighting load **91**a and the second lighting load **92**a, a diffuser **94**a is provided to cover the first lighting load **92**a and the second lighting load **93**a. Further, the first lighting load **92**a and the second lighting load **93**a can be alternatively disposed on the base **91**a. As shown in FIG. **9**B, the first lighting load **92**a comprises a plurality of lighting elements, and the second lighting load **93**a comprises a plurality of lighting elements, wherein a lighting element of the second lighting load **93**a is inserted between the two adjacent lighting elements of the first lighting load **92**a for obtaining uniform color temperature of the diffused light, but present disclosure is not limited thereto.

Another embodiment of the lighting apparatus can be referred to FIG. **9**B. Due to the difference for the appearance of the lighting apparatus, the arrangement of the lighting elements of the first lighting load **92**a and the lighting elements of the second lighting load **93**a shown in FIG. **9**B is different from that shown in FIG. **9**A. As shown in FIG. **9**B, the lighting elements of the first lighting load **92**a and the lighting elements of the second lighting load **93**a are both disposed in a circular arrangement. The lighting elements of the first lighting load **92**a and the lighting elements of the second lighting load **93**a constitute a plurality of concentric circles. The concentric circles of the first lighting load **92**a and the concentric circles of the second lighting load **93**a are interlaced for obtaining uniform color temperature of the diffused or blended light. However, the present disclosure is not restricted thereto. An artisan of ordinary skill in the art will appreciate how to arrange the first

lighting load and the second lighting load covered by the diffuser to obtain the result of uniform color temperature of light.

Furthermore, although the above description of the exemplary embodiments takes infrared ray sensor as a means for detecting user's motion and generating sensing signal, the technology of the present disclosure has no restriction on the types of detection method used. There are quite a few detection methods including touch or touchless means that can be applied to the present invention of the multifunctional electronic switch such as an infrared ray sensor (touchless interface), an electrostatic induction sensor (also touchless interface), a conduction based touch sensor (direct touch interface), or a push button sensor (direct touch interface). Each detection method may require different motion signals to be played by the user but the core technology remains using the time length and format of the binary sensing signals as the message carrier for transmitting the user's choice of working mode. The microcontroller thereby decodes or interprets the received message carrying sensing signals according to the software program written in the OTPROM, recognizes the working mode selected by the user and activates the corresponding loop of subroutine for performance execution.

Similar to the infrared ray sensor, the electrostatic induction sensor can also create a touchless interface. The electrostatic induction sensor generally comprises a copper sheet sensing unit with adequately design shape and packaged with non-conductive material. Such copper sheet sensing unit is further electrically connected to a signal generating circuit similar to the infrared detection sensor unit. The copper sensing unit serves as an anode pole and the human body (normally refers to finger or hand) serves as a cathode pole to form a configuration of a capacitor. When the user's hand is approaching the copper sensing unit, the electric charges are being gradually induced and built up on the surface of the copper sensing unit with increasing density. Consequently, the copper sensing unit changes its electric state from zero voltage state to a growing voltage state. Such voltage level will continue to grow as the user's hand moving closer and closer to the copper sensing unit till reaching a designed threshold point which will trigger the detection circuit to generate a low voltage sensing signal. The distance between the copper sensing unit and the space point where the threshold voltage incurs is defined as the effective detecting zone. Similarly but reversely when the user's hand is moving out from an operative point of the detecting zone of the copper sensing unit, the voltage level will continue to decline till passing the designed threshold point which will trigger the cutoff of the low voltage sensing signal. The time length of the low voltage sensing signal so generated or in other words the time period between moving in and moving out the effective detecting zone can be designed to represent the selection of different working modes. If the time length is shorter than a preset time interval, it means the user's selection is to perform the on/off switch control mode; if the time length is longer than a preset time interval, it means the user's selection is to perform the diming or power level control mode; if two or more low voltage sensing signals are consecutively generated within a preset time interval, in other words the user's hand moving in and out the detecting zone twice or swing across the detecting zone back and forth, it means the user's selection is to perform the color temperature management mode.

For direct touch detection sensors, such as a touch sensor (for example a touch pad) or a push button detection sensor, one touch on the conductive base or one instant press on the control button within a preset time interval will trigger the generation of a single sensing signal which will cause the microcontroller to execute the subroutine of the on/off switch control mode; a long touch on a conductive base or a long press on a control button longer than the preset time interval will trigger the generation of a single sensing signal with time length longer than the preset time interval and the microcontroller responsively will execute the subprogram of dimming control mode. Double instant touches on the conductive base or double instant press on the control button within a preset time interval will trigger the generation of two consecutive sensing signals which will cause the microcontroller to execute the subroutine of color temperature management mode.

FIG. **10**A and FIG. **10**B together provide a good show case to prove the value of the user friendly concept of the present invention. Picture shown in FIG. **10**A is a popular piece of under cabinet light with LED as light source. A manual on/off control switch is built on the right hand side of the rectangular housing and a dimming knob is built on the front panel facing downward. Under cabinet lights are always installed underneath the kitchen cabinets to provide sufficient indirect illumination to the user to do the kitchen work. The under cabinet lights and the kitchen cabinet are always installed at approximately the breast level of the users for the convenience of doing kitchen work so that the users can comfortably do the kitchen work without bending their body and having to work in a glaring environments. The current market piece as shown in FIG. **10**A is not an user friendly device; the user has to either use his or her hand to blindly search the locations of the on/off switch and the dimming knob or to bend his or her body to find the exact locations of the two control units for operation. Additionally, the direct touch to control the on/off switch and dimmer also brings up concerns of contagion and contamination in preparing food in kitchen area and the housewives may have to wash their hands more frequently than necessary.

FIG. **10**B is an application of the present invention for a LED under cabinet light featured with a touchless interface between the user and the under cabinet light. A motion of single swing of user's hand across the detecting zone of the microcontroller based electronic switch **1**b will activate the on/off switch mode alternately turning on and turning off the under cabinet light **2**b. A motion of placing user's hand in the detecting zone exceeding a preset time interval will activate the dimming mode to allow selection of brightness or power level. And a motion of double swings of user's hand across the detecting zone within a preset time interval will activate the color temperature tuning mode to provide the user a possibility to select a desired illumination color temperature. The three basic working modes can be easily managed with simple motions played by the user without the hassles of having to blindly search the control switch and dimming knob, or to bend body to find the location of the control elements or to frequently wash hands to avoid concerns of contagion and contamination in preparing food. This is truly a very user friendly exemplary embodiment of the present disclosure compared with what are currently being sold in the market as shown in FIG. **10**A.

FIG. **10**C is another application of the present invention for a wall switch construction electrically connected to a ceiling light for the performance of three working modes. A motion of single swing across the detecting zone in front of the wall switch **1**c by user's hand within a preset time interval will activate the on/off switch control mode alternately turning on and turning off the ceiling light **2**c. A

motion of placing user's hand in front of the wall switch **1***c* and stay in the detecting zone for a time period longer than a preset time interval will activate the dimming mode to allow the user to select the desired brightness. And a motion of double swings across the detecting zone within a preset time interval will activate the performance of the color temperature management mode to provide the user a convenient way to select a desired illumination color temperature. This new wall switch when compared with conventional switch represents a very user friendly innovation from the easy operation point of view. The conventional touch based wall switch is also a virus gathering spot because of use by many users and the issue of contagion and contamination is always a valid concern even outside the surgical space.

FIG. **10**D is another application of the present invention for a lighting apparatus with a diffuser of hollow body accommodating the lighting loads and the microcontroller based electronic switch. The diffuser is furthered bonded with a metallic threaded cap with bipolar construction for connecting with a power socket. FIG. **10**E is a similar art with a flat diffuser bonded with a metal shade to accommodate the lighting loads and the microcontroller based electronic switch. Both have an infrared ray sensor **310** positioned at the bottom of the diffuser to form a short detection zone for an user to play motion signals for performing the multi functions of controlling on/off mode, dimming mode, color temperature tuning mode or delay shutoff mode.

FIGS. **11**A-D are another exemplary embodiments of the present invention using the aforementioned dual detection device technology for generating message carrying sensing signal to control a lighting apparatus. The dual detection device technology is based on two detection device which are respectively connected with two pins of a microcontroller in an electronic switch to control a lighting apparatus, such as, one first detection device generating message carrying sensing signal to control the color temperature of illumination and one second detection device generating message carrying sensing signal to control the light intensity of illumination. The dual detection device technology can be constructed in two arrangements: the first arrangement is to install the first detection device on one side (left side for instance) of the lighting apparatus and install the second detection device on the other side (right side) of the lighting apparatus. For instance, in FIG. **10**B, the detection device **1***b* being an infrared ray sensor in the center can be relocated to the left side near the end cap as the first detection device to operate the light intensity control subroutine of microcontroller, a second infrared ray sensor as the second detection device is added and installed on the other end of the light apparatus to operate the color temperature control subroutine. The second arrangement is to have two detection device, here, two infrared ray sensors **310**, aligned next to each other along the direction of motion path as shown in FIG. **11**A and FIG. **11**B, or in FIG. **11**C and FIG. **11**D. A hand swing from left side to enter the detecting zones formed by the two infrared ray sensors **310**, as shown in FIG. **11**A and FIG. **11**C, will cause the first infrared ray sensor of the electronic switch to first detect the motion signal before the second infrared ray sensor can detect the same motion signal, the first infrared ray sensor will thereby generate a voltage sensing signal, the microcontroller with a pin connected with the first infrared ray sensor accordingly interprets such voltage sensing signal to activate a subroutine to operate the light intensity control mode. Thus, a first hand-swing from the left side to swing across the detecting zones will turn on the light, a second left side started hand swing will alternately change the light to perform a different state of light intensity including off mode, a left side started hand swing to enter the detecting zones and stay for a time length longer than a preset time interval will activate a free running dimming cycle for the user to select the desired light intensity. Similarly but contrarily in terms of direction for playing motion signal, a right side started hand swing to swing across the detecting zones formed by the two infrared ray sensors, as shown in FIG. **11**B and FIG. **11**D, will cause the second infrared ray sensor to first detect the motion signal before the first infrared ray sensor can detect such motion signal, the second infrared ray sensor thereby will generate another voltage sensing signal sending to the microcontroller of the electronic switch, the microcontroller with another pin connected to the second infrared ray sensor accordingly operates to activate a different subroutine of the microcontroller to operate the color temperature tuning mode. Thus, a right side started motion signal to swing across the detecting zones formed by the two infrared ray sensors will turn on the light to perform the highest color temperature mode, a second right side started motion signal to swing across the detecting zones will alternately change the light to perform a different state of programmed color temperatures including the lowest color temperature mode, a right hand started motion signal to enter and stay in the detecting zone for a time length longer than a preset time interval will activate a free running color temperature tuning cycle for the user to select a desired color temperature for the light. Also, when the hand (or an object) leaves the infrared ray detecting zones, the infrared ray sensors deliver a second voltage sensing signal to terminate the corresponding subroutine.

The present invention of the microcontroller based electronic switch can be extensively used in the control of lighting performance for many I applications can be simply grouped into three main categories of application based on the installation location of the present invention in relation with the lighting devices used as follows:

1) The microcontroller based electronic switch is installed inside a wall electric outlet for controlling a remotely located lighting apparatus which users are unable to reach to play motion control. FIG. **10**C is a representative example.
2) The microcontroller based electronic switch is installed inside the housing of a lighting apparatus which users are able to reach and play motion control. FIG. **10**B of a under cabinet light is a representative example.
3) The microcontroller based electronic switch is directly installed inside a light emitting device with a detecting sensor hiding behind a diffuser and a detecting zone is formed outside nearby the diffuser. FIG. **10**D is a light bulb application with a microcontroller electronic switch built inside the bulb and an infrared ray detecting sensor installed at bottom of the bulb to form a infrared detecting zone near by the bottom of the light bulb. FIG. **10**E is a pendant application with an infrared ray detection sensor built inside and an infrared ray detecting sensor installed at the bottom of a flat diffuser. Both are representative examples classified as detecting sensor installed at bottom of diffuser to form a detecting zone near by the diffuser.

As a summary of the present disclosure the key technology of the present invention involves an electronic switch using a microcontroller with program codes to receive, interpret and execute a message carrying sensing signal converted from an external control signal to control performances of lighting characteristics including light intensity and light color temperature of an LED lamp. The LED lamp

comprises a first LED lighting load featured with a high color temperature electrically connected to a first controllable switching element and a second LED lighting load featured with a low color temperature electrically connected to a second controllable switching element. The first controllable switching element and the second controllable switching element are respectively coupled with the microcontroller. The microcontroller upon receiving the message carrying sensing signal accordingly activates a corresponding subroutine to output a first control signal and a second control signal to respectively control a conduction rate of the first controllable switching device and a conduction rate of the second controllable switching element to respectively transmit electric powers to the first LED lighting load and the second LED lighting load such that a mingled color temperature thru a light diffuser and the light intensity of the LED lamp are thereby determined according to a programmed combination of conduction rates of the first controllable switching device and the second controllable switching device. A detection device serves as an interface between human and the electronic switch to convert the external control signal into the message carrying sensing signal readable and interpretable to the micro controller. The detection device is may be configured as touch less interface and direct touch interface. The touch less interface may be implemented by a wireless method to receive wireless external control signal and convert the wireless external control signal into the message carrying sensing signal readable and interpretable to the microcontroller. The wireless external control signal can be transformed from a motion signal generated with an infrared ray motion sensor, or it can be an electromagnetic wireless signal generated with a wireless receiver or transceiver, or it can be transformed from a voice signal generated with an A.I. (artificial intelligence) based device. The direct touch interface on the other hand uses a wired method to receive the external control signal set by an user, wherein the external control signal can be generated from a push button, a touch pad, a voltage divider, or a power interruption switch or button operated by the user, or a conduction rate of a phase controller set by the user, wherein, if the external control signal is an analogue signal, a conversion circuitry may be included in the detection device or as a virtual circuitry programmable embedded in the microcontroller to convert the analogue signal into the message carrying sensing signal readable and interpretable to the microcontroller.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alterations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A microcontroller based electronic switch for controlling lighting performance of an LED lamp configured with a plurality of LED lighting loads comprising:

a first controllable switching element, electrically connected between a power source and a first LED lighting load for emitting light with a first color temperature;

a second controllable switching element, electrically connected between said power source and a second LED lighting load for emitting light with a second color temperature;

at least one detection device, for detecting at least one external control signal and converting said at least one external control signal into at least one message carrying sensing signal; and

a microcontroller to receive and interpret said at least one message carrying sensing signal generated by said at least one detection device, wherein said microcontroller through a first control pin is electrically coupled to said first controllable switching element, and through a second control pin is electrically coupled to said second controllable switching element, wherein said microcontroller through at least a third control pin receives said at least one message carrying sensing signal from said at least one detection device, wherein said microcontroller controls a conduction state or a cutoff state of said first controllable switching element through said first control pin and said microcontroller controls said conduction state or said cutoff state of said second controllable switching element through said second control pin to control electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said at least one message carrying sensing signal generated by said at least one detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said at least one message carrying sensing signal is characterized with a signal format of a short voltage signal, a long voltage signal, a plurality of short voltage signals, a plurality of long voltage signals or a combination of said short voltage signal and said long voltage signal generated in a preset time interval; wherein said short voltage signal and said long voltage signal are respectively defined either by a time length of a voltage signal or by said time length of a series of pulse signals consecutively generated; wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller manages according to said signal format of said at least one message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming control mode, a color temperature tuning control mode, a color temperature switching control mode, a dimming and color temperature tuning control mode, and a delay shutoff control mode;

wherein when said first controllable switching element and said second controllable switching element are in said conduction state, said microcontroller further controls said electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said signal format of said at least one message carrying sensing signal received, wherein said microcontroller through said first control pin outputs a first control signal to control a conduction rate of said first controllable switching element, said microcontroller through said second control pin outputs a second control signal to control said conduction rate of said second controllable switching element;

wherein said microcontroller is an integrated circuit programmable for generating said first control signal and said second control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal and said second control signal.

2. The microcontroller based electronic switch according to claim 1, wherein said at least one detection device is configured with a touch less interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

3. The microcontroller based electronic switch according to claim 2, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

4. The microcontroller based electronic switch according to claim 2, wherein said touch less interface is a wireless remote control device electrically coupled to said microcontroller to receive and convert said at least one external control signal into said at least one message carrying sensing signal with said signal format interpretable to said microcontroller.

5. The microcontroller based electronic switch according to claim 4, wherein said wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

6. The microcontroller based electronic switch according to claim 1, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said at least one message carrying sensing signal into a wireless control signal to control a lighting performance of at least one remote lighting apparatus.

7. The microcontroller based electronic switch according to claim 6, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wielded signal transmitter, or a radio frequency wireless signal transmitter.

8. The microcontroller based electronic switch according to claim 1, wherein said at least one detection device is configured with a direct touch interface for detecting and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

9. The microcontroller based electronic switch according to claim 8, wherein said direct touch interface is designed with a detection circuitry operated with a push button device or a touch sensor device, wherein said detection circuitry is electrically coupled with said microcontroller, wherein when an user contacts the said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage sensing signal with a time length corresponding to a time interval of said direct touch interface being contacted; when said user withdraws from said direct touch interface, said detection circuitry delivers a second voltage signal; said first voltage sensing signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

10. The microcontroller based electronic switch according to claim 8, wherein said direct touch interface is a detection circuitry electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said at least one message carrying sensing signal with said signal format interpretable to said microcontroller, wherein said microcontroller accordingly activates to perform a relevant working mode.

11. The microcontroller based electronic switch according to claim 8, wherein said direct touch interface is a detection circuitry to detect a voltage signal generated by a voltage divider and to convert a voltage value of said voltage signal into said at least one message carrying sensing signal with said signal format corresponding to said voltage value generated for setting said conduction rate of said first controllable switching element and said second controllable switching element respectively.

12. The microcontroller based electronic switch according to claim 1, wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller operates at least one working mode in response to said signal format of said at least one message carrying sensing signal.

13. The microcontroller based electronic switch according to claim 12, wherein said working mode is said on/off switch control mode, wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller checks electric states of said first controllable switching element and said second controllable switching element , wherein if at least one of said first controllable switching element and said second controllable switching element is in conduction state, said microcontroller accordingly operates to cutoff both said first controllable switching element and said second controllable switching element, wherein if both said first controllable switching element and said second controllable switching element are in cutoff state, said microcontroller accordingly manages to conduct at least one of said first controllable switching element and said second controllable switching element.

14. The microcontroller based electronic switch according to claim 12, wherein said working mode is said delay shutoff control mode; wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller checks the states of said first controllable switching element and said second controllable switching element, wherein if at least one of said first controllable switching element and said second controllable switching element is in conduction state, said microcontroller accordingly activates a process of delay shutoff to cutoff both said first controllable switching element and said second controllable switching element after a preset delay time; wherein upon a maturity of said preset delay time both said first controllable switching element and said second controllable switching element are instantly and simultaneously cutoff such that said LED lamp is thereby turned off; wherein if both said first controllable switching element and said second controllable switching element are in cutoff state, said microcontroller instantly and accordingly manages to conduct at least one of said first controllable switching element and said second controllable switching element.

15. The microcontroller based electronic switch according to claim 12, wherein said working mode is said dimming control mode, wherein said first control signal and said second control signal are designed to operate with an

arrangement that said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are unidirectionally and proportionally adjusted with the same pace such that a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load through a light diffuser is maintained at a constant level while a total light intensity of said first LED lighting load and said second LED lighting load is being proportionally adjusted according to said signal format of said at least one message carrying sensing signal.

16. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said color temperature tuning control mode;

wherein said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are reversely adjusted with the same pace such that a total light intensity of said first LED lighting load and said second LED lighting load is maintained at a constant level while a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load thru a light diffuser is proportionately adjusted according to said signal format of said at least one message carrying sensing signal.

17. The microcontroller based electronic switch according to claim **12**, wherein said working mode is a color temperature switching control mode;

wherein said microcontroller is operated in accordance with a light color temperature switching scheme comprising at least two light color temperature performances , wherein each of said at least two light color temperature performances is respectively activated by said at least one external control signal, wherein each of said at least two light color temperature performances is further operated with a predetermined combination of conduction rates respectively for controlling said first controllable switching element and said second controllable switching element, wherein for performing each of said at least two color temperature performances, said first control signal and said second control signal are designed and predetermined to operate with an arrangement that said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are reversely and complementarily adjusted such that the total light intensity of said first LED lighting load and said second LED lighting load is maintained at a constant level while a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load through a light diffuser is adequately adjusted according to said predetermined combination of conduction rates for respectively controlling said first controllable switching element and said second controllable switching element.

18. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is a short power interruption signal generated by a power switch, a push button or a touch sensor, wherein said at least one detection device is configured with a direct touch interface comprising a detection circuitry for detecting said short power interruption signal and converting said short power interruption signal into said at least one message carrying sensing signal interpretable to said microcontroller for activating a relevant light color temperature performance in said color temperature switching scheme.

19. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is a voltage signal generated by at least one push button switch and at least one touch pad switch, a slide switch or a rotary switch , wherein said at least one detection device is configured with a direct touch interface comprising a circuitry for detecting said voltage signal and converting said voltage signal into said at least one message carrying sensing signal interpretable to said microcontroller for activating a relevant light color temperature performance in said color temperature switching scheme.

20. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is a voltage signal generated by a voltage divider, wherein said at least one detection device is configured with a direct touch interface comprising a circuitry for detecting a voltage value of said voltage signal and converting said voltage value into said at least one message carrying sensing signal interpretable to said microcontroller for activating a relevant light color temperature performance in said color temperature switching scheme.

21. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is an infrared light reflected from an object, wherein said at least one detection device is an active infrared ray sensor for detecting said infrared light reflected from an object and converting said infrared light reflected from an object into said at least one message carrying sensing signal interpretable to said microcontroller for activating a relevant light color temperature performance in said light color temperature switching scheme, wherein said active infrared ray sensor comprises an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from said object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein when said time length of said first voltage signal is shorter than a predetermined time interval, said microcontroller operates said light color temperature switching scheme to activate a relevant light color temperature performance, wherein when said time length of said first voltage signal is longer than said predetermined time interval, said microcontroller continues to reversely and complimentarily adjust said conduction rates between said first controllable switching element and said second controllable switching element till the time length of said first voltage signal ends to perform said color temperature tuning control mode.

22. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is a wireless external control signal, wherein said at least one detection device is wireless signal receiver to receive said wireless external control signal and convert said wireless external control signal into said at least one message carrying sensing signal interpretable to said microcontroller for

activating a relevant light color temperature performance in said light color temperature switching scheme.

23. The microcontroller based electronic switch according to claim **22**, wherein said wireless signal receiver is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

24. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said dimming and color temperature tuning control mode; wherein said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first controllable switching element is reduced at a faster pace than said conduction rate of said second controllable switching element being reduced such that a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load thru a light diffuser continues to change to a warmer illumination along with a continuous reduction of light intensity, wherein during a cycle of said dimming and color temperature tuning control mode, said light intensity and said mingled color temperature of said first LED lighting load and said second LED lighting load are determined by said signal format of said at least one message carrying sensing signal received from said detection device.

25. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said dimming and color temperature tuning control mode, wherein said first control signal and said second control signal are designed with an arrangement that said conduction rate of said first controllable switching element is proportionately decreased according to said signal format of said at least one message carrying sensing signal while said conduction rate of said second controllable switching element is maintained at constant level till being turned off to create a dim to warm effect, wherein during a cycle of said dimming and color temperature tuning control mode, a light intensity and a mingled color temperature of a diffused light of said first LED load and said second LED load thru a light diffuser are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

26. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said color temperature tuning control mode, wherein when said microcontroller receives a first said at least one message carrying sensing signal, said microcontroller operates to activate a free running process to perform an automatic color temperature tuning cycle, wherein said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are continuously and reversely changed with the same pace such that the total light intensity of said first LED lighting load and said second LED lighting load is maintained at a constant level while a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load thru a light diffuser is continuously and proportionately changed from a higher color temperature to a lower color temperature or from a lower color temperature to a higher temperature, wherein when said microcontroller receives a second said at least one message carrying sensing signal during said automatic color temperature tuning cycle, said microcontroller operates to terminate said free running process with said mingled color temperature being thereby determined and memorized for repetitive performance.

27. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said dimming and color temperature tuning control mode, wherein when said microcontroller receives said at least one message carrying sensing signal with a relevant said signal format, said microcontroller operates to activate a relevant process to successively and respectively change conduction rates of said first switching element and said second switching element from maximum conduction rates to minimum conduction rates, and continuously from the minimum conduction rates to the maximum conduction rates to complete a dimming and color temperature tuning cycle, wherein a moment at which said at least one message carrying sensing signal ceases during said dimming and color temperature tuning cycle, a total light intensity and a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load through a light diffuser are thereby determined and memorized for repetitive performance.

28. The microcontroller based electronic switch according to claim **27**, wherein during a first half cycle period of said dimming and color temperature tuning cycle said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first controllable switching element is decreased at a faster pace than said conduction rate of said second controllable switching element being decreased such that said first controllable switching element leads said second controllable switching element in both decreasing said conduction rate and reaching a cutoff state during said first half cycle period of said dimming and color temperature tuning cycle to create a dim to warm effect; wherein during a second half cycle period of said dimming and color temperature cycle said conduction rate of said first controllable switching element is increased at a faster pace than said conduction rate of said second controllable switching element being increased with a time phase delay such that both said first controllable switching element and said second controllable switching element simultaneously reach a full conduction state at the end of full cycle period of said dimming and color temperature tuning cycle to create a brighten to cold effect, wherein at any time during a full cycle of said dimming and color temperature tuning mode, a total light intensity and a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load thru the light diffuser are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

29. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said delay shutoff control mode; wherein when said microcontroller receives said message carrying sensing signal, said microcontroller checks the states of said first controllable switching element and said second controllable switching element, wherein if at least one of said first controllable switching element and said second controllable switching element is in conduction state, said microcontroller accordingly activates a process of delay shutoff to completely cutoff both said first controllable switching element and said second controllable switching element after a preset delay time; wherein during said preset delay time said microcontroller manages to gradually reduce the conduction rates of said first controllable switching element and said second controllable switching element with the same pace till both said first controllable switching element and said second controllable switching element are completely cut off at the end of said preset delay time such that said first LED lighting load and said second LED

lighting of said LED lamp are slowly dimmed to zero with the same pace such that said LED lamp is slowly turned off with color temperature unchanged, wherein if both said first controllable switching element and said second controllable switching element are in cutoff state, said microcontroller instantly and accordingly manages to conduct at least one of said first controllable switching element and said second controllable switching element.

30. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said delay shutoff control mode; wherein when said microcontroller receives said message carrying sensing signal, said microcontroller checks the states of said first controllable switching element and said second controllable switching element, wherein if at least one of said first controllable switching element and said second controllable switching element is in conduction state, said microcontroller accordingly activates a process of delay shutoff to cutoff both said first controllable switching element and said second controllable switching element after a preset delay time; wherein during said preset delay time said microcontroller manages to instantly, proportionally and respectively reduce conduction rates of said first controllable switching element and said second controllable switching element to lower levels for a shorter time interval, wherein upon a maturity of said shorter time interval said microcontroller further manages to gradually reduce conduction rates of said first controllable switching element and said second controllable switching element with the same pace till said first controllable switching element and said second controllable switching element are both cut off at the end of said preset delay time such that said first LED lighting load and said second LED lighting load are both dimmed with the same pace such that LED lamp is slowly turned off with color temperature unchanged, wherein if both said first controllable switching element and said second controllable switching element are in cutoff state, said microcontroller instantly and accordingly manages to conduct at least one of said first controllable switching element and said second controllable switching element.

31. A microcontroller based electronic switch for controlling lighting performance of an LED lamp configured with a plurality of LED lighting loads comprising:

a first controllable switching element, electrically connected between a first LED lighting load for emitting light with a first color temperature and a power source;

a second controllable switching element, electrically connected between a second LED lighting load for emitting light with a second color temperature and said power source;

a first detection device for detecting a first external control signal and converting said first external control signal into a first message carrying sensing signal;

a second detection device for detecting a second external control signal and converting said second external control signal into a second message carrying sensing signal; and

a microcontroller through a first control pin receives said first message carrying sensing signal generated by said first detection device, said microcontroller through a second control pin receives said second message carrying sensing signal generated by said second detection device, wherein said microcontroller through a third control pin is electrically coupled to said first controllable switching element, wherein said microcontroller through a fourth control pin is electrically coupled to said second controllable switching element, wherein said microcontroller respectively controls conduction state or cutoff state of said first controllable switching element and said second controllable switching element to control electric power transmissions from said power source respectively to said first LED lighting load and to said second LED lighting load according to said first message carrying sensing signal and said second message carrying sensing signal generated respectively by said first detection device and said second detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said first detection device is a touch less interface to receive and convert said first external control signal into said first message carrying sensing signal interpretable to said microcontroller;

wherein said second detection device is a direct touch interface to receive and convert said second external control signal into said second message carrying sending signal interpretable to said microcontroller;

wherein said first message carrying sensing signal and said second message carrying sensing signal are characterized with a signal format of a short voltage signal, a long voltage signal, a plurality of short voltage signals, a plurality of voltage signals or a combination of said short voltage signal and said long voltage signal generated in a preset time interval;

wherein the short voltage signal and the long voltage signal are respectively defined either by a time length of a voltage signal or by the time length of a series of pulse signals consecutively generated; wherein when said microcontroller receives said first message carrying sensing signal or said second message carrying sensing signal, said microcontroller manages according to said signal format of said first message carrying sensing signal or said second message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming control mode, a color temperature tuning control mode, a dimming and color temperature tuning control mode, and a delay shutoff control mode;

wherein when said first controllable switching element and said second controllable switching element are in conduction state, said microcontroller further controls electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said signal format of said first message carrying sensing signal or said second message carrying sensing signal received, wherein said microcontroller through said third control pin outputs a first control signal to control a conduction rate of said first controllable switching element, said microcontroller through said fourth control pin outputs a second control signal to control said conduction rate of said second controllable switching element;

wherein said microcontroller is an integrated circuit programmable for generating said first control signal and said second control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal and said second control signal.

32. The microcontroller based electronic switch according to claim **31**, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different

voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said first message carrying sensing signal to be delivered to said microcontroller.

33. The microcontroller based electronic switch according to claim **31**, wherein said touch less interface of said first detection device is a wireless remote control device electrically coupled to said microcontroller to receive and convert a wireless external control signal into said first message carrying sensing signal with said signal format interpretable to said microcontroller.

34. The microcontroller based electronic switch according to claim **33**, wherein the wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

35. The microcontroller based electronic switch according to claim **31**, wherein said direct touch interface of said second detection device is a detection circuitry operated with a push button or a touch sensor, wherein said detection circuitry is electrically coupled with said microcontroller, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted wherein when said user withdraws from said direct touch interface, said second detection device delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said second message carrying sensing signal to be delivered to said microcontroller.

36. The microcontroller based electronic switch according to claim **31**, wherein said direct touch interface of said second detection device is a detection circuitry electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said second message carrying sensing signal with said signal format interpretable to said microcontroller for performing various working modes.

37. The microcontroller based electronic switch according to claim **31**, wherein said direct touch interface of said second detection device is a circuitry to detect a voltage signal generated by a voltage divider and to convert a voltage value of said voltage signal into said second message carrying sensing signal with said signal format corresponding to said voltage value for controlling and setting said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element respectively.

38. The microcontroller based electronic switch according to claim **31**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said first message carrying sensing signal or said second message carrying sensing signal into a wireless control signal to control a lighting performance of at least one remote lighting apparatus.

39. The microcontroller based electronic switch according to claim **38**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter, or a radio frequency wireless signal transmitter.

40. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first LED lighting load and said second LED lighting load to create a diffused light with a mingled color temperature; and

a microcontroller based electronic switch electrically connected to said first LED lighting load and to said second LED lighting load, said microcontroller based electronic switch further comprising:

a first switching element, electrically connected between said first LED lighting load and a power source;

a second switching element, electrically connected between said second LED lighting load and said power source;

at least a detection device, for detecting at least one external control signal and converting said at least one external control signal into at least one message carrying sensing signal;

a microcontroller to receive and interpret said at least one message carrying sensing signal generated by said at least one detection device, wherein said microcontroller through a first control pin is electrically coupled to said first switching element, and through a second control pin is electrically coupled to said second switching element, wherein said microcontroller through a third control pin receives said at least one message carrying sensing signal from said at least one detection device, wherein said microcontroller controls a conduction state or a cutoff state of said first switching element through said first control pin and said microcontroller controls said conduction state or said cutoff state of said second switching element through said second control pin to control electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said at least one message carrying sensing signal generated by said at least one detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said at least one message carrying sensing signal is characterized with a signal format of a short voltage signal, a long voltage signal, a plurality of short voltage signals, a plurality of long voltage signals or a combination of short voltage signal and long voltage signal generated in a preset time interval; wherein said short voltage signal and said long voltage signal are respectively defined either by a time length of a voltage signal or by said-time length of a series of pulse signals consecutively generated; wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller operates according to said signal format of said at least one message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming control mode, a color temperature tuning control mode, a color temperature switching mode, a dimming and color temperature tuning control mode, and a delay shutoff control mode;

wherein when said first switching element and said second switching element are in said conduction state, said

microcontroller further controls said electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said signal format of said at least one message carrying sensing signal received, wherein said microcontroller through said first control pin outputs a first control signal to change a conduction rate of said first switching element, said microcontroller through said second control pin outputs a second control signal to change said conduction rate of said second switching element;

wherein said microcontroller is an integrated circuit programmable for generating said first control signal and said second control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal and said second control signal.

41. The lighting apparatus according to claim **40**, wherein both said first switching element and said second switching element are controllable switching element, wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller operates to output said first control signal and said second control signal with an arrangement that said conduction rate of said first switching element and said conduction rate of said second switching element are reversely adjusted with the same pace such that a total electric power transmitted to said first LED lighting load and said second LED lighting load is maintained at a constant level while said mingled color temperature of said lighting apparatus is proportionately adjusted according to said signal format of said at least one message carrying sensing signal to perform said color temperature tuning control mode.

42. The lighting apparatus according to claim **40**, wherein both said first switching element and said second switching element are controllable switching elements, wherein said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first switching element and said conduction rate of said second switching element are unidirectionally and proportionally adjusted with the same pace such that said mingled color temperature of said lighting apparatus is maintained at a constant level while a light intensity of said lighting apparatus is being proportionately adjusted according to said signal format of said at least one message carrying sensing signal to perform said dimming control mode.

43. The lighting apparatus according to claim **40**, wherein at least said first switching element is a controllable switching element, wherein when said dimming and color temperature tuning control mode is performed, said microcontroller manages to output said first control signal to proportionately reduce said conduction rate of said first switching element such that said first LED lighting load with said first color temperature is dimmed according to said signal format of said at least one message carrying sensing signal, wherein said microcontroller manages to output said second control signal to control said conduction rate of said second switching element such that said second LED lighting load with said second color temperature operates at a constant power level before being turned off to create a dim to warm effect, wherein during a cycle of said dimming and color temperature tuning control mode, a light intensity and said mingled color temperature of said lighting apparatus are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

44. The lighting apparatus according to claim **40**, wherein said first switching element and said second switching element are controllable switching elements, wherein when said dimming and color temperature tuning control mode is performed, said microcontroller outputs said first control signal to control a conduction rate of said first switching element, said microcontroller outputs said second control signal to control said conduction rate of said second switching element, wherein said first control signal and said second control signal are designed to operate with an arrangement that said first LED lighting load and said second LED lighting load are respectively dimmed in such a way that said first LED lighting load leads said second LED lighting load in reaching a turnoff state in performing said dimming and color temperature tuning control mode such that said mingled color temperature created by said diffuser of said lighting apparatus continues to change to a warmer illumination along with a continuous reduction of light intensity according to said signal format of said at least one message carrying sensing signal, wherein during a cycle of said dimming and color temperature tuning control mode, a light intensity and said mingled color temperature of said lighting apparatus are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

45. The lighting apparatus according to claim **40**, wherein said first LED lighting load is configured with a plurality of light emitting diodes and said second LED lighting load is configured with a plurality of light emitting diodes , wherein said first switching element comprises a plurality of transistors with each transistor electrically coupled to at least one of the plurality of light emitting diodes of said first LED lighting load, wherein said conduction rate of said first switching element is adjustable thru outputting at least one control signal to respectively control conduction or cutoff of at least one said transistor selected, wherein when said dimming and color temperature tuning control mode is performed, said microcontroller successively outputs said at least one control signal to decreasingly change said conduction rate of said first switching element such that said first LED lighting load with said first color temperature is turned off gradually, wherein said microcontroller successively output said at least one control signal to manage said conduction rate of said second switching element such that said second LED lighting load with said second color temperature operates at a constant electric power level before being turned off to create a dim to warm effect, wherein during a cycle of said dimming and color temperature tuning mode, a light intensity and said mingled color temperature of said lighting apparatus are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

46. The lighting apparatus according to claim **40**, wherein said at least one detection device is a touch less interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

47. The lighting apparatus according to claim **46**, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and

leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

48. The lighting apparatus according to claim **47**, wherein said lighting apparatus is an LED light bulb constructed with said microcontroller based electronic switch, and said at least one detection device is said active infrared ray sensor being mounted in or on said LED bulb housing for detecting said at least one external control signal.

49. The lighting apparatus according to claim **46**, wherein said touch less interface is a wireless remote control device electrically coupled to said microcontroller to receive and convert at least one external control signal into said at least one message carrying sensing signal with said signal format interpretable to said microcontroller.

50. The lighting apparatus according to claim **49**, wherein said wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

51. The lighting apparatus according to claim **40**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said at least one message carrying sensing signal into at least one wireless control signal to control a lighting performance of at least one remote lighting apparatus.

52. The lighting apparatus according to claim **51**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter, or a radio frequency wireless signal transmitter.

53. The lighting apparatus according to claim **40**, wherein said at least one detection device is a direct touch interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

54. The lighting apparatus according to claim **53**, wherein said direct touch interface is a detection circuitry operated with a push button device or a touch sensor device, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted; wherein when said user withdraws from said direct touch interface, said detection circuitry delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

55. The lighting apparatus according to claim **53**, wherein said direct touch interface is a detection circuitry electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said at least one message carrying sensing signal interpretable to said microcontroller for performing various working modes.

56. The lighting apparatus according to claim **53**, wherein said direct touch interface is a circuitry to detect a voltage signal generated by a voltage divider and convert a voltage value of said voltage signal into said at least one message carrying sensing signal with said signal format corresponding to said voltage value-generated for setting conduction rates of said first switching element and said second switching element respectively.

57. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a third LED lighting load for emitting light with a third color temperature;

a diffuser, covering said first LED lighting load, said second LED lighting load and said third LED lighting load to create a diffused light with a mingled color temperature;

a microcontroller based electronic switch electrically connected to said first LED lighting load, said second LED lighting load and said third LED lighting load, said microcontroller based electronic switch further comprising:

a first controllable switching element, electrically connected between said first LED lighting load and a power source;

a second controllable switching element, electrically connected between said second LED lighting load and the power source;

a third controllable switching element, electrically connected between said third LED lighting load and the power source;

at least one detection device, for detecting at least one external control signal and converting said at least one external control signal into at least one message carrying sensing signal; and

a microcontroller to receive and interpret said at least one message carrying sensing signal generated by said at least one detection device, wherein said microcontroller through a first control pin is electrically coupled to said first controllable switching element, said microcontroller through a second control pin is electrically coupled to said second controllable switching element, and said microcontroller through a third control pin is electrically coupled to said third controllable switching element; wherein said microcontroller through a fourth control pin receives said at least one message carrying sensing signal from said at least one detection device, wherein said microcontroller controls a conduction state or a cutoff state of said first controllable switching element through said first control pin, said microcontroller controls said conduction state or said cutoff state of said second controllable switching element through said second control pin, and said microcontroller controls the said conduction state or said cutoff state of said third controllable switching element through said third control pin to control electric power transmission levels from said power source respectively to said first LED lighting load, to said second LED lighting load and to said third LED lighting load according to said at least one message carrying sensing signal generated by said at least one detection device;

wherein said first color temperature is higher than said second color temperature and said second color temperature is higher than said third color temperature;

wherein said at least one message carrying sensing signal is characterized with a signal format of a short voltage signal, a long voltage signal, a plurality of short voltage signals, a plurality of long signals or a combination of said short voltage signal and said long voltage signal generated in a preset time interval; wherein said short voltage signal and said long voltage signal are respectively defined either by a time length of a voltage signal or by said time length of a voltage signal comprising a series of pulse signals consecutively generated; wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller operates according to said signal format of said at least one message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming control mode, a color temperature tuning control mode, a dimming and color temperature tuning control mode and a delay shutoff control mode;

wherein when said first controllable switching element, said second controllable switching element and said third controllable switching element are in said conduction state, said microcontroller further controls said electric power transmission levels from the power source respectively to said first LED lighting load, to said second LED lighting load and to said third LED lighting load according to said signal format of said at least one message carrying sensing signal received, wherein said microcontroller through said first control pin outputs a first control signal to change conduction rate of said first controllable switching element, said microcontroller through said second control pin outputs a second control signal to change conduction rate of said second controllable switching element and said microcontroller through said third control pin outputs a third control signal to change conduction rate of said third controllable switching element;

wherein when said microcontroller receives said at least one message carrying sensing signal said signal format for performing said dimming and color temperature tuning control mode, said microcontroller manages to output different control signals to said first controllable switching element, to said second controllable switching element and to said third controllable switching element with an arrangement that said first LED lighting load leads said second LED lighting load and said second LED lighting load leads said third LED lighting load in reaching a turnoff state such that said mingled color temperature of said lighting apparatus continues to change to a warmer illumination along with a continuous reduction of light intensity according to said signal format of said at least one message carrying sensing signal, wherein during a cycle of said dimming and color temperature tuning control mode, a light intensity and said mingled color temperatures of the lighting apparatus are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device;

wherein said microcontroller is an integrated circuit programmable for generating said first control signal, said second control signal and said third control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal, said second control signal and said third control signal.

58. The lighting apparatus according to claim **57**, wherein said at least one detection device is configured with a touch less interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

59. The lighting apparatus according to claim **58**, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

60. The lighting apparatus according to claim **59**, wherein said lighting apparatus is a LED light bulb constructed with said microcontroller based electronic switch, and said at least one detection device is said active infrared ray sensor being mounted in or on said LED bulb housing for detecting said at least one external control signal.

61. The lighting apparatus according to claim **58**, wherein said touch less interface is a wireless remote control device electrically coupled to said microcontroller to receive and convert said at least one external control signal into said at least one message carrying sensing signal with said signal format interpretable to said microcontroller.

62. The lighting apparatus according to claim **61**, wherein said wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

63. The lighting apparatus according to claim **57**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said at least one message carrying sensing signal into a wireless control signal to control a lighting performance of at least one remote lighting apparatus.

64. The lighting apparatus according to claim **63**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter, or a radio frequency wireless signal transmitter.

65. The lighting apparatus according to claim **57**, wherein said detection device is configured with a direct touch interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

66. The lighting apparatus according to claim **65**, wherein said direct touch interface is a detection circuitry operated with a push button device or a touch sensor device, wherein said detection circuitry is electrically coupled with said microcontroller, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted; wherein when said user withdraws from said direct touch interface, said detection

circuitry delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

67. The lighting apparatus according to claim **65**, wherein said direct touch interface is a detection circuitry electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said at least one message carrying sensing signal interpretable to said microcontroller for performing various working modes.

68. The lighting apparatus according to claim **65**, wherein said direct touch interface is a circuitry to detect a voltage signal generated by a voltage divider and to convert a voltage value of said voltage signal into said at least one message carrying sensing signal with said signal format corresponding to said voltage value generated for setting conduction rates of said first switching element and said second switching element respectively.

69. A method of creating a dim to warm effect for controlling lighting performance of an LED lamp comprising:

using at least a first LED lighting load with a high color temperature and a second LED lighting load with a low color temperature to form a lighting unit of said LED lamp;

electrically coupling a switching circuitry to said first LED lighting load and to said second LED lighting load to respectively deliver different average electric powers to said first LED lighting load and to said second LED lighting load for generating different illuminations respectively ;

using a detection device to detect an external control signal and to convert said external control signal into a message carrying sensing signal with a time length;

using a microcontroller to output at least one control signal to control a conduction rate of said switching circuitry electrically coupled to said first LED lighting load and to said second LED lighting load according to said time length of said message carrying sensing signal received from said detection device; and

using a diffuser to cover at least said first LED lighting load with said high color temperature and said second LED lighting load with said low color temperature to create a diffused light with a mingled color temperature;

wherein said switching circuitry comprises at least one semiconductor switching device; wherein when a dimming cycle is performed, said microcontroller receives said message carrying sensing signal and responsively outputs said at least one control signal to reduce conduction rate of said switching circuitry coupled to said first LED lighting load and to said second LED lighting load with an arrangement that said first LED lighting load with said high color temperature leads said second LED lighting load with said low color temperature in reaching a turnoff state during said dimming cycle such that said mingled color temperature of said LED lamp continues to change to a warmer illumination along with a continuous reduction of light intensity according to said time length of said message carrying sensing signal to create a dim to warm effect; wherein at any time during said dimming cycle a light intensity and said mingled color temperature of said lighting apparatus are determined by said time length of said message carrying sensing signal received from said detection device;

wherein said microcontroller is an integrated circuit programmable for generating said at least one control signal, or an application specific integrated circuit (ASIC) custom made for generating said at least one control signal.

70. The method of creating a dim to warm effect for controlling lighting performance of an LED lamp according to claim **69**, wherein during said dimming cycle said switching circuitry manages to continually reduce said average electrical power delivered to said first LED lighting load and said switching circuitry simultaneously manages to deliver a constant said average electric power to said second LED lighting load till at a time when said first LED lighting load is turned off and then said switching circuitry manages to reduce said average electric power to said second LED lighting load till said second LED lighting load is also turned off completely, such that said first LED lighting load leads said second LED lighting load in reaching a turnoff state before the end of said dimming cycle.

71. The method of creating a dim to warm effect for controlling lighting performance. of an LED lamp according to claim **69**, wherein during said dimming cycle said switching circuitry manages to continuously reduce said average electric power delivered to said first LED lighting load at a faster pace than reducing said average electric power delivered to said second LED lighting load such that said first LED lighting load leads said second LED lighting load in reaching a turnoff state in performing said dimming cycle to create a dim to warm effect through a light diffuser according to said time length of said message carrying sensing signal, wherein at any time during said dimming cycle, a light intensity and said mingled color temperature of said LED lamp are determined by said time length of said message carrying sensing signal received from said detection device.

72. The method of creating a dim to warm effect for controlling lighting performance of an LED lamp according to claim **69**, wherein during said dimming cycle, said switching circuitry manages to continuously reduce said average electric power delivered to said first LED lighting load at a faster pace such that said first LED lighting load leads said second LED lighting load in reaching a turnoff state during said dimming cycle, wherein in order to accelerate color temperature tuning pace along with a continuous reduction of light intensity of said LED lamp, said switching circuitry initially manages to increase said average electric power delivered to said second LED lighting load with a pace slower than the reduction pace of said average electric power delivered to said first LED lighting load such that a total average electric power delivered to said first LED lighting load and said second LED lighting load continues to decline while said mingled color temperature of said LED lamp continues to change to a warmer illumination at a faster pace to perform a faster dim to warm process, wherein when a dim to warm process ceases at a time point when said first LED lighting load reaches a turnoff state is an inflection time point for said switching circuitry to reversely manage to decrease said average electric power delivered to said second LED lighting load till reaching said turnoff state at the ending point of said dimming cycle, such that the dimming of said LED lamp continues to perform with said low color temperature of said second LED lighting load thru the end of said dimming cycle to complete a full cycle of said dim to warm process, wherein at any time during said dimming cycle , said light intensity and said mingled color tempera-

ture of said LED lamp are determined by said time length of said message carrying sensing signal received from said detection device.

73. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first LED lighting load and said second LED lighting load to create a diffused light with a mingled color temperature; and

a microcontroller based electronic switch, electrically coupled to said first LED lighting load and said second LED lighting load, wherein said microcontroller based electronic switch further comprising:

a first controllable switching element, electrically coupled between said first LED lighting load and a power source;

a second controllable switching element , electrically coupled between said second LED lighting load and the power source;

a first detection device for detecting a first external control signal and converting said first external control signal into a first message carrying sensing signal;

a second detection device for detecting a second external control signal and converting said second external control signal into a second message carrying sensing signal; and

a microcontroller to receive and interpret said first message carrying sensing signal and said second message carrying sensing signal to respectively activate a corresponding process for controlling and setting a light intensity level and a mingled color temperature level of said lighting apparatus;

wherein said microcontroller through a first control pin is electrically coupled to said first controllable switching element and through a second control pin is electrically coupled to said second controllable switching element, wherein said microcontroller through a third control pin receives said first message carrying sensing signal from said first detection device, wherein said microcontroller through a fourth control pin receives said second message carrying sensing signal from said second detection device;

wherein said color temperature of said first LED lighting load is higher than said color temperature of said second LED lighting load;

wherein said first message carrying sensing signal and said second message carrying sensing signal are characterized with a signal format of a short voltage signal, a long voltage signal or a plurality of short voltage signals generated in a preset time interval; wherein the short voltage signal and the long voltage signal are respectively defined either by a time length of a voltage signal or by the time length of a voltage signal comprising a series of pulse signals consecutively generated;

wherein said first detection device is a first direct touch interface designed to detect said first external control signal and convert said first external control signal into said first message carrying sensing signal interpretable to said microcontroller for controlling and setting said mingled color temperature level of said lighting apparatus;

wherein when said microcontroller receives said first message carrying sensing signal from said first detection device, said microcontroller manages to activate a first process to output a first control signal to reduce conduction rate of said first controllable switching element and meantime to output a second control signal to increase said conduction rate of said second controllable switching element, or vice versa, according to said signal format of said first message carrying sensing signal with an arrangement that a total power delivered to said first LED lighting load and said second LED lighting load remains unchanged;

wherein said second detection device is a second direct touch interface designed to detect a second external control signal and convert said second external control signal into said second message carrying sensing signal interpretable to said microcontroller for controlling and setting said light intensity level of said lighting apparatus;

wherein when said microcontroller receives said second message carrying sensing signal from said second detection device, said microcontroller manages further to determine a total power level transmitted to said first LED lighting load and said second LED lighting load according to said signal format of said second message carrying sensing signal with an arrangement that the ratio between the power delivered to said first LED lighting load and a power delivered to said second LED lighting load remains at a constant level; wherein said microcontroller outputs a third control signal to reduce conduction rate of said first controllable switching element and meantime to output a fourth control signal to reduce conduction rate of said second controllable switching element with the same pace, or vice versa, such that said mingled color temperature of said diffused light through said diffuser remains unchanged.

74. The lighting apparatus according to claim **73**, wherein a power switch is used to control on state and off state of said lighting apparatus; wherein when said power switch is turned on said lighting apparatus responsively perform an illumination and wherein when said power switch is turned off the illumination of said lighting apparatus is immediately shutoff.

75. The lighting apparatus according to claim **73**, wherein a third detection device is further installed and coupled to a control pin of said microcontroller to detect a voltage signal generated by a third direct touch interface and convert said voltage signal into a third message carrying sensing signal for controlling an on/off performance of said lighting apparatus; wherein when said microcontroller receives said third message carrying sensing signal, said microcontroller operates to turn on or turn off said lighting apparatus alternatively.

76. The lighting apparatus according to claim **73**, wherein said first direct touch interface of said first detection device comprises a circuitry to detect a voltage signal generated by a voltage divider and convert a voltage value of said voltage signal into said first message carrying sensing signal.

77. The lighting apparatus according to claim **73**, wherein said second direct touch interface of said second detection device comprises a circuitry to detect a voltage signal generated by a voltage divider and convert a voltage value of said voltage signal into said second message carrying sensing signal.

78. The lighting apparatus according to claim **73**, wherein said first direct touch interface of said first detection device comprise a circuitry to detect a voltage signal generated by a push button interface or a touch pad interface, and convert said voltage signal into said first message carrying sensing signal with a time length corresponding to a time interval of

said push button interface or said touch pad interface being continuously contacted by an user for controlling and setting the color temperature level of the lighting apparatus.

79. The lighting apparatus according to claim **73**, wherein said second direct touch interface of said second detection device comprises a circuitry to detect a voltage signal generated by a push button interface or a touch pad interface and convert said voltage signal into said second message carrying sensing signal with a time length corresponding to a time interval of said push button interface or touch pad interface being continuously contacted by an user for controlling and setting said light intensity level of said lighting apparatus.

80. The lighting apparatus according to claim **73**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said first message carrying sensing signal or said second message carrying sensing signal into a wireless signal to remotely control a lighting performance of at least one lighting apparatus.

81. The lighting apparatus according to claim **80**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter or a radio frequency wireless signal transmitter.

82. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first LED lighting load and said second LED lighting load to create a diffused light with a mingled color temperature;

a clock, providing clock time information to be used for scheduling variation of color temperature of said lighting apparatus according to a programmed pattern of color temperature; and

a microcontroller based electronic switch electrically connected to said first LED lighting load and said second LED lighting load;

wherein said microcontroller based electronic switch further comprising:

a first controllable switching element, electrically connected between said first LED lighting load and a power source for controlling a first electrical power level transmitted to said first LED lighting load;

a second controllable switching element, electrically connected between said second LED lighting load and said power source for controlling a second electrical power level transmitted to said second LED lighting load;

a detection device, for detecting an external control signal and converting said external control signal into a messaging carrying sensing signal; and

a microcontroller to receive and interpret said message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is also electrically connected between said second controllable switching element and said detection device, said microcontroller is designed to execute a task of managing illumination characteristics of said lighting apparatus including light intensity and mingled color temperature;

wherein said microcontroller controls a conduction state, a cutoff state or conduction rates of said first controllable switching element and said second controllable switching element to control electric power transmission levels from said power source respectively to said first LED lighting load and said second LED lighting load according to a process designed for an automatic tuning of said mingled color temperature of said lighting apparatus based on said clock time information provided by said clock and according to a signal format of said message carrying sensing signal generated by said detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said clock time information is either received from said clock electrically connected to said microcontroller or received from a mobile device configured with a clock time capacity through a wireless signal receiver electrically connected with said microcontroller;

wherein said signal format is a short voltage signal, a long voltage signal or a plurality of voltage signals generated in a preset time interval; wherein said short voltage signal and said long voltage signal are respectively defined either by a time length of a voltage signal or by said time length of a voltage signal comprising a series of pulse signals consecutively generated;

wherein when said microcontroller receives said message carrying sensing signal, said microcontroller manages to activate a corresponding process according to said signal format of said message carrying sensing signal to perform one of various working modes including an on/off switch control mode, a dimming control model, a color temperature tuning control mode and a delay shutoff mode.

83. The lighting apparatus according to claim **82**, wherein said detection device is configured with a touch less interface for detecting said external control signal and converting said external control signal into said message carrying sensing signal interpretable to said microcontroller.

84. The lighting apparatus according to claim **83**, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said message carrying sensing signal to be delivered to said microcontroller.

85. The lighting apparatus according to claim **83**, wherein said touch less interface is a wireless remote control device electrically coupled to said microcontroller to receive and to convert a wireless external control signal into said message carrying sensing signal with said signal format interpretable to said microcontroller.

86. The lighting apparatus according to claim **85**, wherein said wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver or a RF (radio frequency) wireless signal receiver, wherein said wireless external control signal, said clock and said clock time information are received from a mobile device.

87. The lighting apparatus according to claim **82**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said message carrying sensing signal into a wireless control signal to control a lighting performance of at least one remote lighting apparatus.

88. The lighting apparatus according to claim **87**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter, or a radio frequency wireless signal transmitter.

89. The lighting apparatus according to claim **82**, wherein said detection device is configured with a direct touch interface for detecting said external control signal and converting said external control signal into said message carrying sensing signal interpretable to said microcontroller.

90. The lighting apparatus according to claim **89**, wherein said direct touch interface is a detection circuitry operated with a push button or a touch sensor, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage sensing signal with a time length corresponding to said time interval of said direct touch interface being contacted; when said user withdraws from said direct touch interface, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal; wherein said first voltage sensing signal with said time length is a basic format for configuring said message carrying sensing signal to be delivered to said microcontroller.

91. The lighting apparatus according to claim **89**, wherein said direct touch interface is a circuitry to detect a voltage signal generated by a voltage divider and convert a voltage value of said voltage signal into said message carrying sensing signal with said signal format corresponding to said voltage value for setting a total conduction rate of said first controllable switching element and said second controllable switching element.

92. The lighting apparatus according to claim **82**, wherein when said color temperature tuning control mode is performed, said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are reversely adjusted with the same pace controlled by said microcontroller such that a total power level transmitted to said first LED lighting load and said second LED lighting load remains unchanged, wherein said mingled color temperature of said lighting apparatus is varied based on a predetermined color temperature schedule comprising paired combinations of different conduction rates respectively set for operating said first controllable switching element and said second controllable switching element for a selection according to said clock time information at the time when said message carrying sensing signal is received by said microcontroller.

93. The lighting apparatus according to claim **82**, wherein when the first controllable switching element and the second controllable switching element are in the conduction state, said microcontroller further controls a first electrical power level transmitted from the power source to the first LED lighting load and a second electrical power level transmitted from the power source to the second LED lighting load according to the signal format of said message carrying sensing signal received from said detection device, wherein the first electrical power level transmitted to the first LED lighting load and the second electrical power level transmitted to the second LED lighting load are designed to be unidirectionally and proportionally adjusted with the same pace such that the ratio of said first electrical power level to said second electrical power level is maintained at a constant level to perform the dimming control mode.

94. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first LED lighting load and said second LED lighting load to create a diffused light with a mingled color temperature; and

a microcontroller based electronic switch electrically connected to said first LED lighting load and said second LED lighting load, comprising:

a first controllable switching element, electrically connected between said first LED lighting load and a power source;

a second controllable switching element, electrically connected between said second LED lighting load and said power source;

a detection device, for detecting and converting an external control signal into a message carrying sensing signal;

a wireless signal transmitter, for transmitting a coded wireless control signal converted from said message carrying sensing signal; and

a microcontroller to receive and interpret said message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is also electrically connected between said second controllable switching element and said detection device, said microcontroller is also electrically coupled to said wireless signal transmitter for controlling a lighting performance of at least a second lighting apparatus located in a different location;

wherein said microcontroller controls a conduction state, a cutoff state or conduction rates of said first controllable switching element and said second controllable switching element to control electric power transmission levels from said power source respectively to said first LED lighting load and said second LED lighting load according to said message carrying sensing signal generated by said detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said detection device is a wireless remote control device electrically coupled to a pin of said microcontroller to receive and convert a wireless external control signal into said message carrying sensing with a signal format interpretable to said microcontroller, wherein said signal format of said message carrying sensing signal is a voltage signal with a short time length, a voltage signal with a long time length or a plurality of voltage signals generated in a preset time interval; wherein the short voltage signal and the long voltage signal are respectively defined either by a time length of a voltage signal or by the time length of a voltage signal comprising a series of pulse signals consecutively generated;

wherein when said microcontroller receives said message carrying sensing signal, said microcontroller manages to activate a corresponding process according to said signal format of said message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming

control mode for selecting light intensity, a color temperature tuning mode for selecting light color, a color temperature switching mode and a delay timer control mode for managing delay shutoff before switching off the light.

95. The lighting apparatus according to claim **94**, wherein said wireless remote control device is a Wi-Fi wireless control signal receiver, a Bluetooth wireless control signal receiver or a RF (radio frequency) wireless control signal receiver.

96. The lighting apparatus according to claim **94** wherein said lighting apparatus is configured as a commanding lamp in a lighting family comprising a plurality of member lamps installed in different locations in a living space for providing illumination; wherein said commanding lamp receives said wireless external control signal and converts said wireless external control signal into said message carrying sensing signal interpretable to said microcontroller to control lighting performances of said commanding lamp or at least one member lamp, wherein for controlling said at least one member lamp, said microcontroller manages to convert said message carrying sensing signal into said coded wireless control signal for transmitting to at least one member lamp, wherein upon receiving said coded wireless control signal said wireless remote control device of said at least one member lamp manages to convert said coded wireless control signal into said message carrying sensing signal interpretable to said microcontroller of said at least one member lamp for controlling lighting performance of said at least one member lamp.

97. The lighting apparatus according to claim **94**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter or a radio frequency wireless signal transmitter.

98. The lighting apparatus according to claim **94**, wherein said microcontroller comprises a memory for saving or installing an application program (APP) or a software program, wherein said application program (APP) from an internet or a cloud server is downloaded for updating the memory of said microcontroller.

99. A lighting apparatus comprising;

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first lighting load and said second lighting load to create a diffused light with a mingled color temperature; and

a microcontroller based electronic switch electrically connected to said first LED lighting load and said second LED lighting load, comprising:

a first controllable switching element, electrically connected between said first LED lighting load and a power source;

a second controllable switching element, electrically connected between said second LED lighting load and said power source;

a detection device, for detecting an external control signal and converting said external control signal into a message carrying sensing signal; and

a microcontroller to receive and interpret said message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is electrically connected between said second controllable switching element and said detection device, said microcontroller controls a conduction state, a cutoff state or conduction rates of said first controllable switching element and said second controllable switching element to control electric power transmission levels from said power source respectively to said first LED lighting load with said first color temperature and said second LED lighting load with said second color temperature according to said message carrying sensing signal generated by said detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said detection device is a detection circuit electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said message carrying sensing signal interpretable to said microcontroller, wherein when said microcontroller receives said message carrying sensing signal to perform a color temperature switching control mode, said microcontroller operates to change conduction rates of said first controllable switching element and said second controllable switching element according to paired combinations of conduction rates between said first controllable switching element and said second controllable switching element to alternately perform a different mingled color temperature, wherein the total conduction rate of said first controllable switching element and said second controllable switching element is managed at a constant level.

100. The lighting apparatus according to claim **99**, wherein said paired combinations of conduction rates between said first controllable switching element and said second controllable comprises at least a first combination and a second combination, wherein said first combination is designed with an arrangement that said first controllable switching element is in a full conduction state while said second controllable switching element is in a complete cutoff state, wherein said second combination is designed with an arrangement that said first controllable switching element is in a complete cutoff state while said second controllable switching element is in a full conduction state, said lighting apparatus thereby alternatively performs between a first color temperature illumination and a second color temperature illumination according to said message carrying sensing signal received by said microcontroller.

101. A microcontroller based electronic switch for controlling a lighting performance of an LED lamp configured with a plurality of LED lighting loads comprising

a first controllable switching element, electrically connected between a first LED lighting load for emitting light with a first color temperature and a power source;

a second controllable switching element, electrically connected between a second LED lighting load for emitting light with a second color temperature and said power source;

a first detection device for detecting a first external control signal and converting said first external control signal into a first message carrying sensing signal;

a second detection device for detecting a second external control signal and converting said second external control signal into a second message carrying sensing signal; and

a microcontroller through a first control pin receives said first message carrying sensing signal generated by said first detection device, said microcontroller through a

second control pin receives said second message carrying sensing signal generated by said second detection device, wherein said microcontroller through a third control pin is electrically coupled to said first controllable switching element, wherein said microcontroller through a fourth control pin is electrically coupled to said second controllable switching element;

wherein said first color temperature is higher than said second color temperature;

wherein said first detection device and said second detection device are direct touch interface;

wherein when said first controllable switching element and said second controllable switching element are in conduction state, said microcontroller further controls electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said first message carrying sensing signal or said second message carrying sensing signal received, wherein said microcontroller through said third control pin outputs a first control signal to control conduction rate of said first controllable switching element, said microcontroller through said fourth control pin outputs a second control signal to control conduction rate of said second controllable switching element;

wherein said first message carrying sensing signal and said second message carrying sensing signal are characterized with a signal format with a time length, wherein said time length of said signal format is defined either by a time duration of a voltage signal or by said time duration of a series of pulse signals consecutively generated; wherein when said microcontroller receives said first message carrying sensing signal, said microcontroller manages to activate a first process to control a light intensity of a diffused light through a light diffuser covering said first LED lighting load and said second LED lighting load according to said time length of said first message carrying sensing signal, wherein when said microcontroller receives said second message carrying sensing signal, said microcontroller manages to activate a second process to reversely control said light intensity of said diffused light through said light diffuser according to said time length of said second message carrying sensing signal, wherein said first process and said second process are designed to operate a reverse function to each other for adjusting said light intensity of said LED lamp; wherein said first process operates to increase and set said light intensity of said

LED lamp by proportionately increasing conduction rates of said first controllable switching element and said second controllable switching element according to said time length of said first message carrying sensing signal, wherein said second process operates to decrease and set said light intensity of said LED lamp by proportionately decreasing conduction rates of said first controllable switching element and said second controllable switching element according to said time length of said second message carrying sensing signal;

wherein said microcontroller is an integrated circuit programmable for generating said first control signal and said second control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal and said second control signal.

102. The microcontroller based electronic switch according to claim **101**, wherein said first detection device and said second detection device are integrated into a seesaw device, wherein one end of said seesaw device performs the function of said first detection device while the other end of said seesaw device performs the function of said second detection device for adjusting and setting said light intensity of said LED lamp.

103. The microcontroller based electronic switch according to claim **101**, wherein a third detection device is furthered installed and coupled to a control pin of said microcontroller for controlling an on/off performance of said LED lamp, wherein said third detection device is a direct touch interface electrically coupled to said microcontroller for detecting a third external control signal and converting said third external control signal into a third message carrying sensing signal, wherein when said microcontroller receives said third message carrying sensing signal, said microcontroller operates to alternatively turn on or turn off said LED lamp.

104. The microcontroller based electronic switch according to claim **101**, wherein a power switch is further installed to turn on or turn off said LED lamp.

105. The microcontroller based electronic switch according to claim **101**, wherein said direct touch interface is a detection circuitry operated with a push button device or a touch sensor device, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted; wherein when said user withdraws from said direct touch interface, said detection circuitry delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said first message carrying sensing signal and said second message carrying sensing signal to be delivered to said microcontroller.

106. A microcontroller based electronic switch for controlling a lighting performance of an LED lamp configured with a plurality of LED lighting loads comprising

a first controllable switching element, electrically connected between a first LED lighting load for emitting light with a first color temperature and a power source;

a second controllable switching element, electrically connected between a second LED lighting load for emitting light with a second color temperature and said power source;

a first detection device for detecting a first external control signal and converting said first external control signal into a first message carrying sensing signal;

a second detection device for detecting a second external control signal and converting said second external control signal into a second message carrying sensing signal; and

a microcontroller through a first control pin receives said first message carrying sensing signal generated by said first detection device, said microcontroller through a second control pin receives said second message carrying sensing signal generated by said second detection device, wherein said microcontroller through a third control pin is electrically coupled to said first controllable switching element, wherein said microcontroller through a fourth control pin is electrically coupled to said second controllable switching element;

wherein said first color temperature is higher than said second color temperature;

wherein said first detection device and said second detection device are direct touch interfaces;

wherein when said first controllable switching element and said second controllable switching element are in

conduction state, said microcontroller further controls electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said first message carrying sensing signal or said second message carrying sensing signal received, wherein said microcontroller through said third control pin outputs a first control signal to control conduction rate of said first controllable switching element, said microcontroller through said fourth control pin outputs a second control signal to control conduction rate of said second controllable switching element;

wherein said first message carrying sensing signal and said second message carrying sensing signal are characterized with a signal format with a time length, wherein said time length of said signal format is defined either by a time duration of a voltage signal or by said time duration of a series of pulse signals consecutively generated;

wherein when said microcontroller receives said first message carrying sensing signal, said microcontroller manages to activate a first process to control a light color temperature of a diffused light through a light diffuser covering said first LED lighting load and said second LED lighting load of said LED lamp according to said time length of said first message carrying sensing signal, wherein when said microcontroller receives said second message carrying sensing signal, said microcontroller manages to activate a second process to reversely control said light color temperature of said diffused light through said light diffuser according to said time length of said second message carrying sensing signal, wherein said first process and said second process are designed to operate a reverse function to each other for adjusting said light color temperature of said diffused light through said light diffuser of the LED lamp; wherein said first process operates to decrease conduction rate of said first controllable switching element and at the same time to increase conduction rate of said second controllable switching element with an arrangement that the total electric power transmitted to said first LED lighting load and said second LED lighting load is maintained at a constant level for decreasing and setting said light color temperature of said LED lamp according to said time length of said first message carrying sensing signal, wherein said second process operates to increase conduction rate of said first controllable switching element and at the same time to decrease conduction rate of said second controllable switching element with said arrangement that the total electric power transmitted to said first LED lighting load and said second LED lighting load is maintained at the constant level for increasing and setting said light color temperature of said LED lamp.

107. The microcontroller based electronic switch according to claim **106**, wherein said first detection device and said second detection device are integrated into a seesaw device, wherein one end of said seesaw device performs a function of said first detection device while the other end of said seesaw device performs a function of said second detection device for adjusting and setting said light color temperature of said LED lamp.

108. The microcontroller based electronic switch according to claim **106**, wherein a third detection device is furthered installed and coupled to a control pin of said microcontroller for controlling an on/off switch operation of said LED lamp, wherein said third detection device is a direct touch interface electrically coupled to said microcontroller for detecting a third external control signal and converting said third external control signal into a third message carrying sensing signal, wherein when said microcontroller receives said third message carrying sensing signal, said microcontroller operates to alternatively turn on or turn off said LED lamp.

109. The microcontroller based electronic switch according to claim **106**, wherein a power switch is further installed to turn on or turn off said LED lamp.

110. The microcontroller based electronic switch according to claim **106**, wherein said direct touch interface is a detection circuitry operated with a push button device or a touch sensor device, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted; wherein when said user withdraws from said direct touch interface, said detection circuitry delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said first message carrying sensing signal and said second message carrying sensing signal to be delivered to said microcontroller.

* * * * *

EXHIBIT B

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(12) **United States Patent**
Chen

(10) **Patent No.: US 10,187,947 B2**
(45) **Date of Patent: *Jan. 22, 2019**

(54) **LIFE-STYLE LED SECURITY LIGHT**

(71) Applicant: **Chia-Teh Chen**, Taipei (TW)

(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 13 days.

This patent is subject to a terminal disclaimer.

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(22) Filed: **Dec. 28, 2017**

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H05B 33/08 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H05B 33/0854*** (2013.01); ***F21S 9/03*** (2013.01); ***F21V 17/02*** (2013.01); ***G08B 5/36*** (2013.01); ***G08B 13/1895*** (2013.01); ***G08B 15/00*** (2013.01); ***G08B 15/002*** (2013.01); ***H02J 7/35*** (2013.01); ***H05B 33/083*** (2013.01); ***H05B 33/0809*** (2013.01); ***H05B 33/0815*** (2013.01); ***H05B 33/0818*** (2013.01); ***H05B 33/0824*** (2013.01); ***H05B 33/0827*** (2013.01); ***H05B 33/0872*** (2013.01); ***H05B 37/02*** (2013.01); ***H05B 37/0218*** (2013.01); ***H05B 37/0227*** (2013.01); ***H05B 37/0281*** (2013.01); ***H05B 39/042*** (2013.01); ***H05B 39/044*** (2013.01); *F21Y 2115/10* (2016.08);
(Continued)

(58) **Field of Classification Search**
CPC H05B 33/0815; H05B 33/0845; H05B 33/0848; H05B 37/0218; H05B 37/0227; H05B 37/0281
USPC 315/149, 152, 154, 307, 308, 312
See application file for complete search history.

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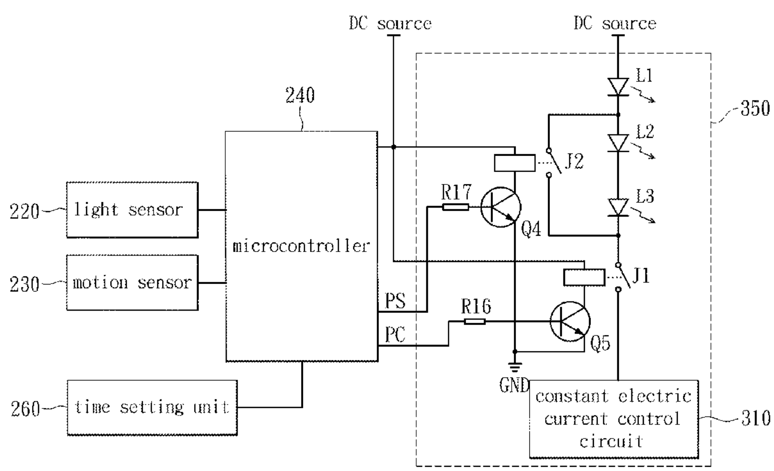
(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A two-level LED security light within it has a light-emitting unit including an LED load which may be turned on or turned off by a loading and power control unit activated by a light sensing control unit and a motion sensing unit. When the motion sensing unit detects a motion signal, the light-emitting unit is switched to a high level illumination for a predetermined time length adjustable by a time setting unit, and then the loading and power control unit manages to turn off the light-emitting unit thru a soft off process. The LED load is configured with a plurality of LEDs accommodating to the power supply unit wherein a voltage V across each LED is confined in a range $V_{th}<V<V_{max}$, with V_{th} being a minimum voltage to turn on the LED and V_{max} a maximum voltage to avoid damaging the LED.

61 Claims, 16 Drawing Sheets



Related U.S. Application Data

No. 15/230,752, filed on Aug. 8, 2016, now Pat. No. 9,743,480, which is a continuation of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

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H05B 39/04	(2006.01)
F21S 9/03	(2006.01)
F21V 17/02	(2006.01)
G08B 5/36	(2006.01)
H02J 7/35	(2006.01)
G08B 13/189	(2006.01)
F21Y 115/10	(2016.01)
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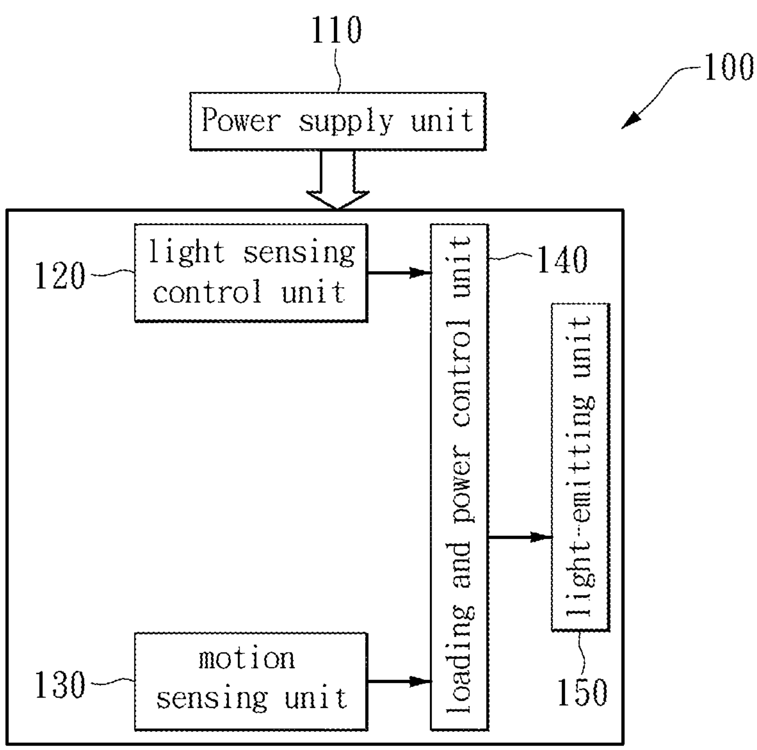

110
100
Power supply unit
120
light sensing control unit
140
loading and power control unit
light-emitting unit
130
motion sensing unit
150

FIG. 1

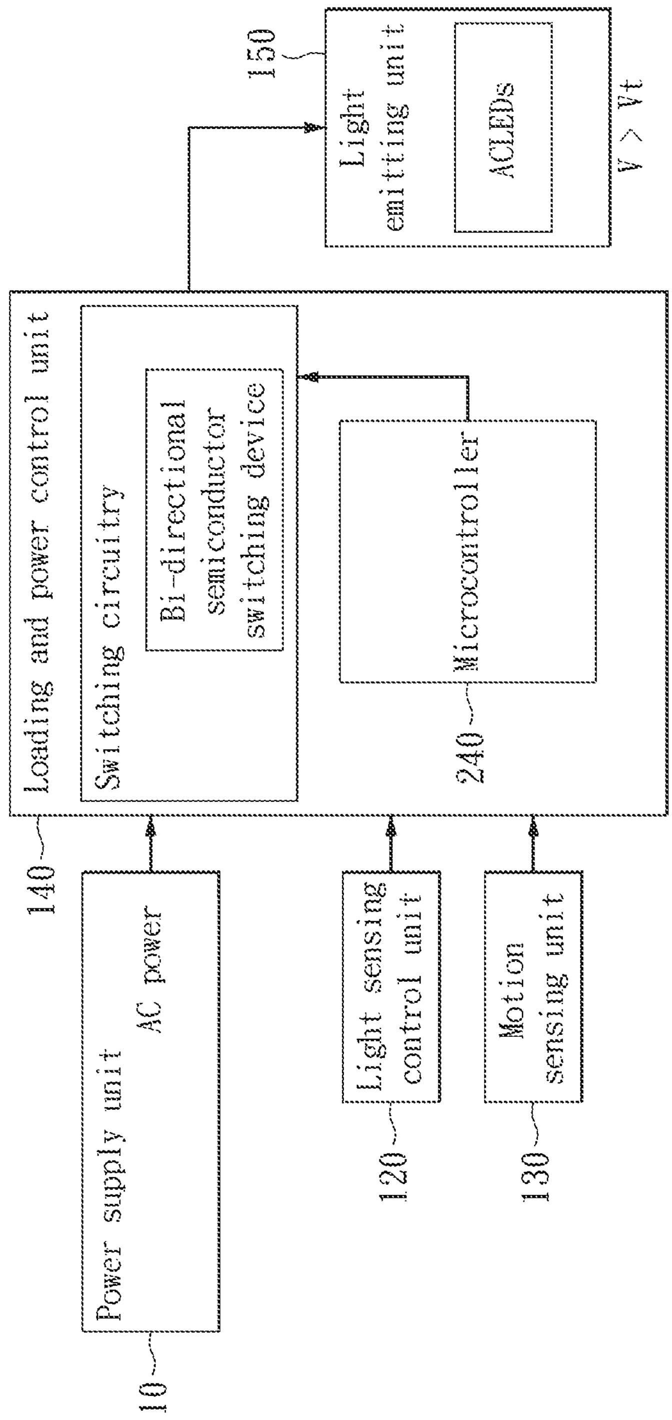
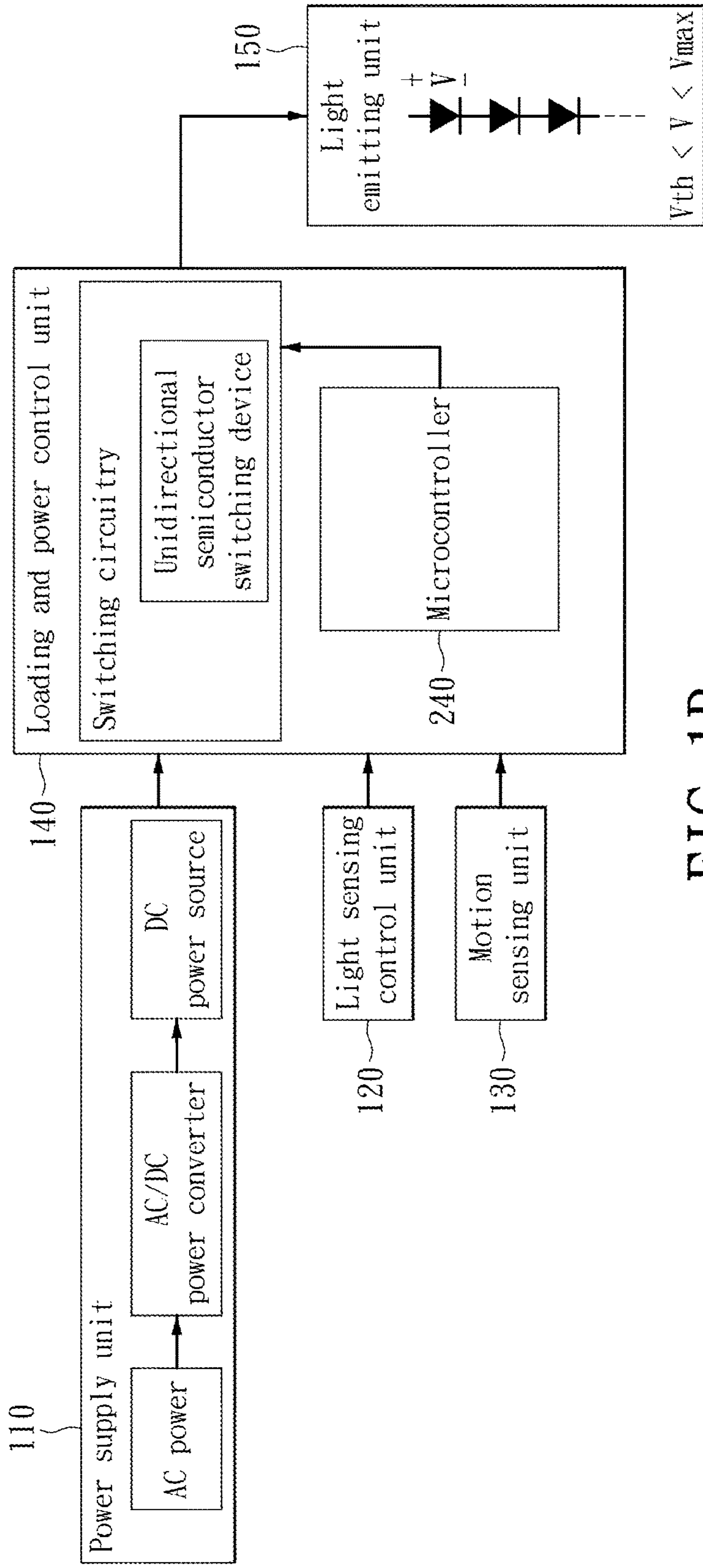
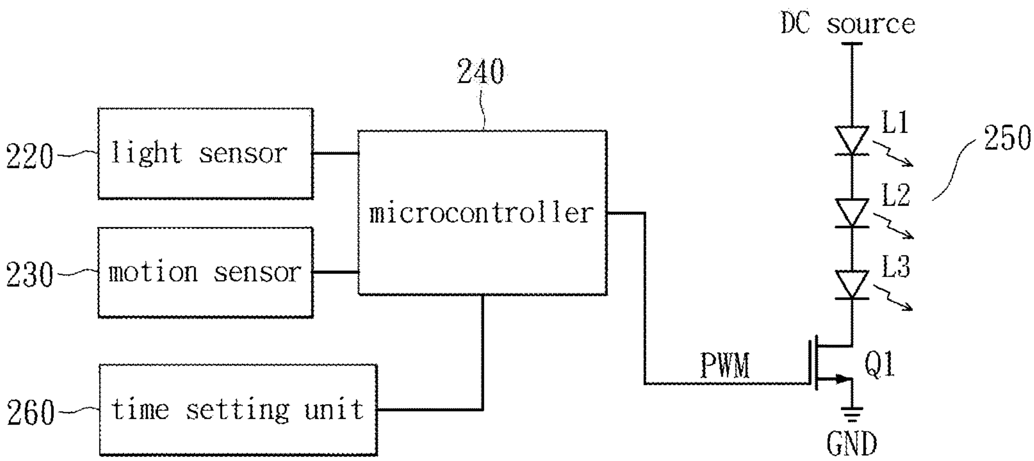

150
Light emitting unit
ACLEDs
V > Vt
Loading and power control unit
Switching circuitry
Bi-directional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
110
Light sensing control unit
120
Motion sensing unit
130

FIG. 1A



150
Light emitting unit
+ V −
Vth < V < Vmax
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
AC/DC power converter
DC power source
110
Light sensing control unit
120
Motion sensing unit
130

FIG. 1B



DC source
240
220
light sensor
microcontroller
L1
250
L2
230
motion sensor
L3
PWM
Q1
260
time setting unit
GND

FIG. 2A

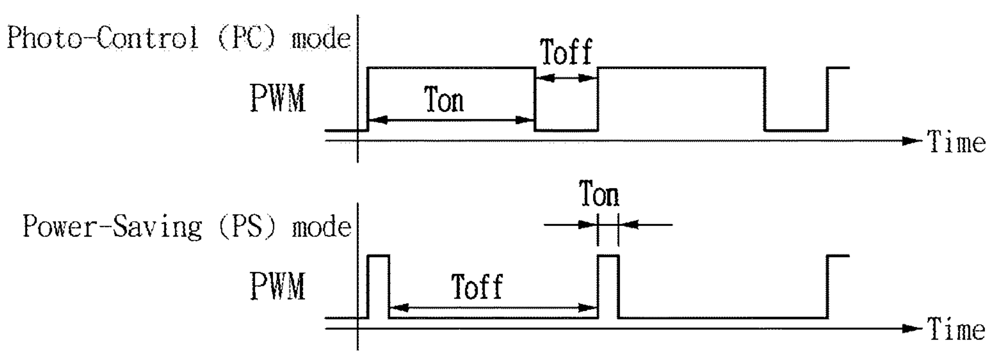
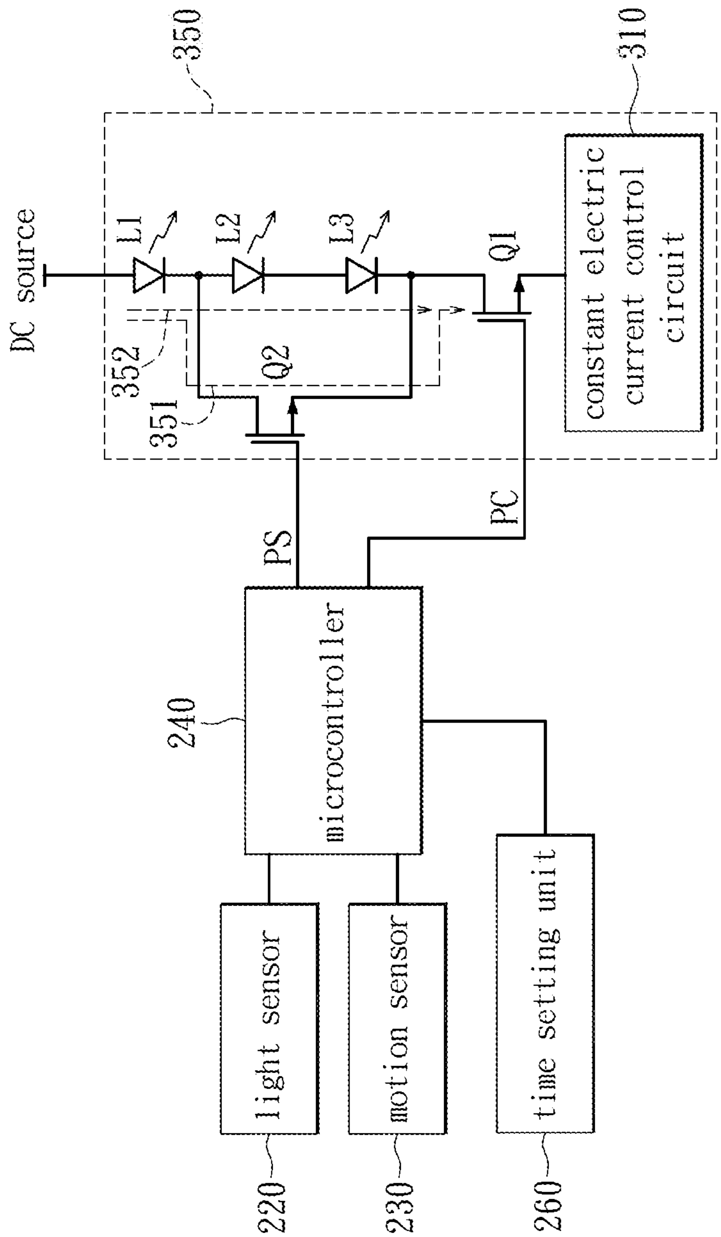


Photo-Control (PC) mode
Toff
PWM
Ton
Time
Ton
Power-Saving (PS) mode
PWM
Toff
Time

FIG. 2B



DC source
L1
L2
L3
Q1
Q2
350
310
352
351
constant electric current control circuit
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

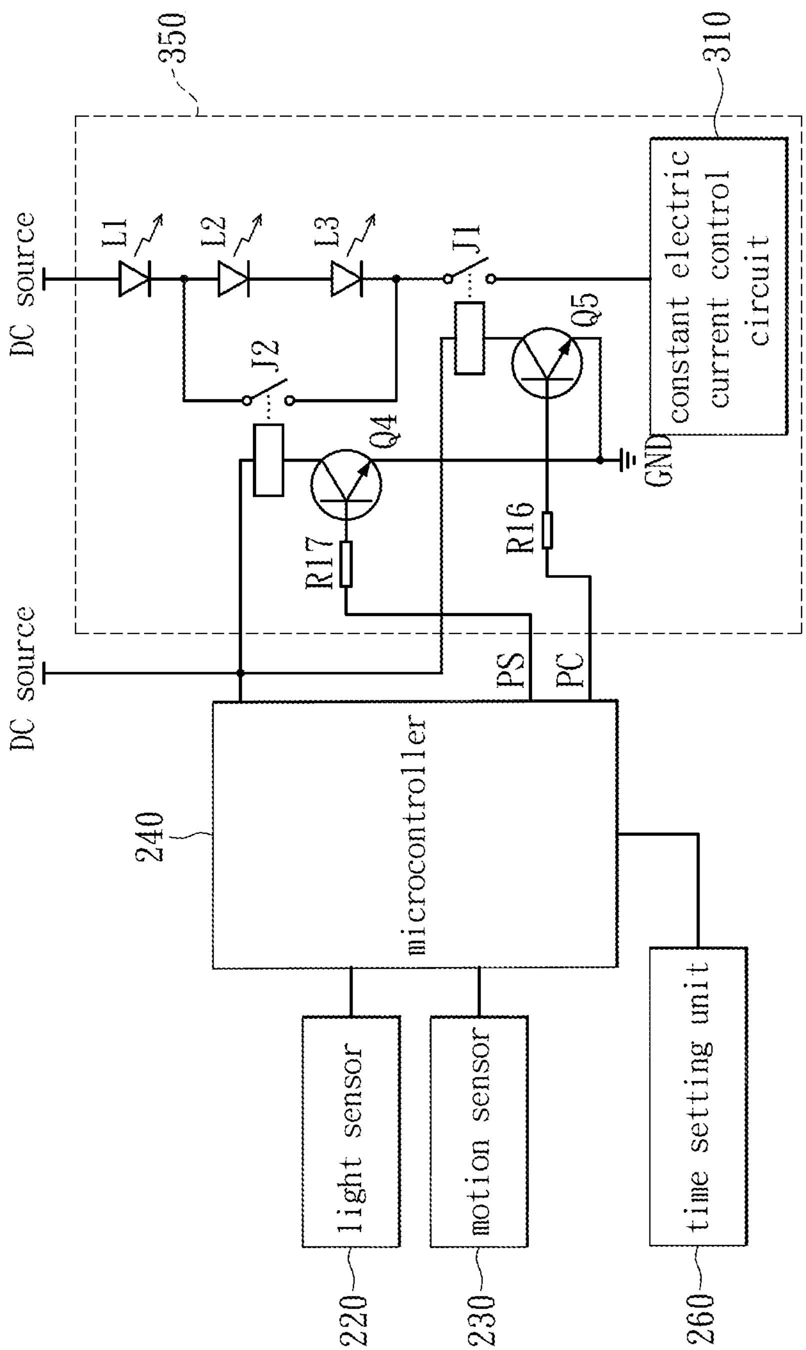

350
310
DC source
L1
L2
L3
J1
J2
Q5
Q4
constant electric current control circuit
GND
R16
R17
DC source
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

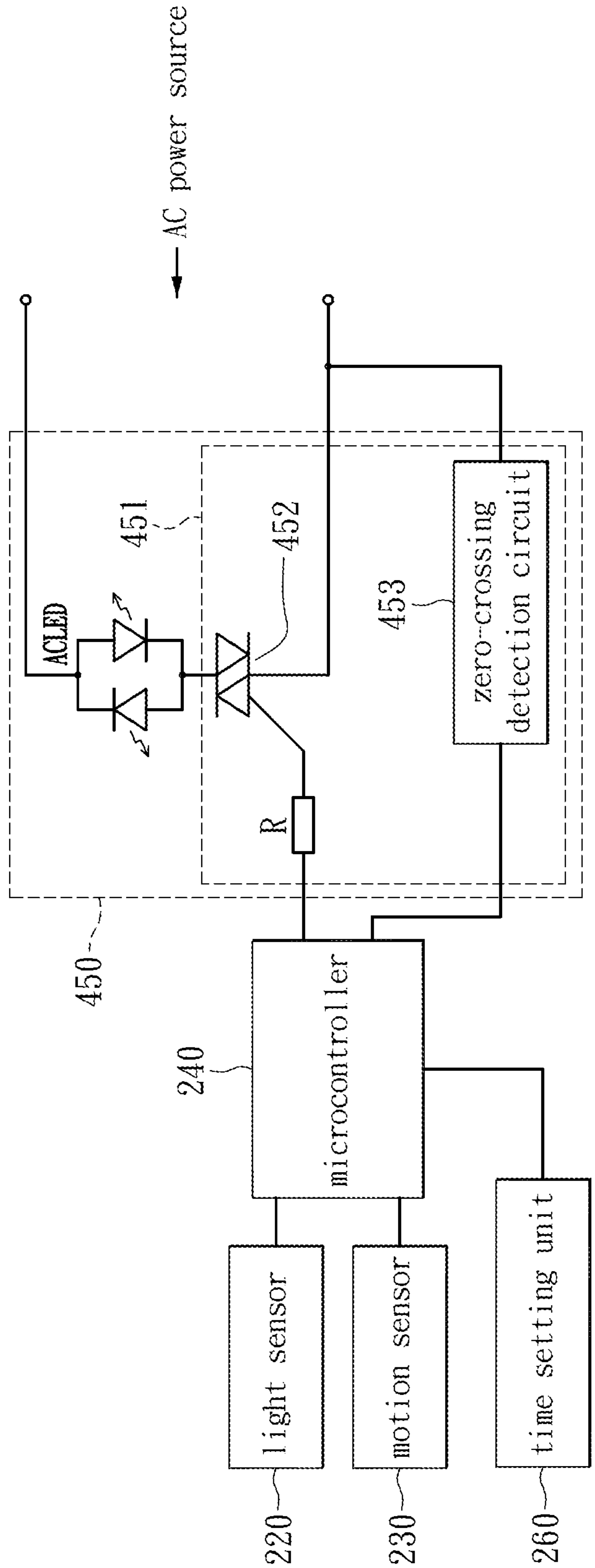

AC power source
ACLED
451
452
453
zero-crossing detection circuit
R
450
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

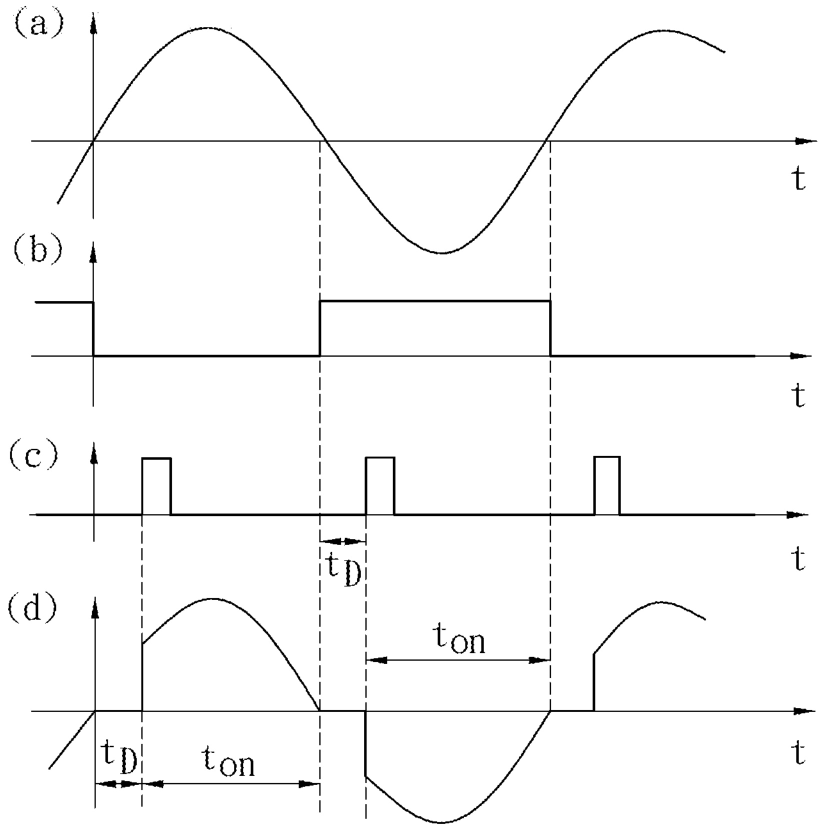


FIG. 4B

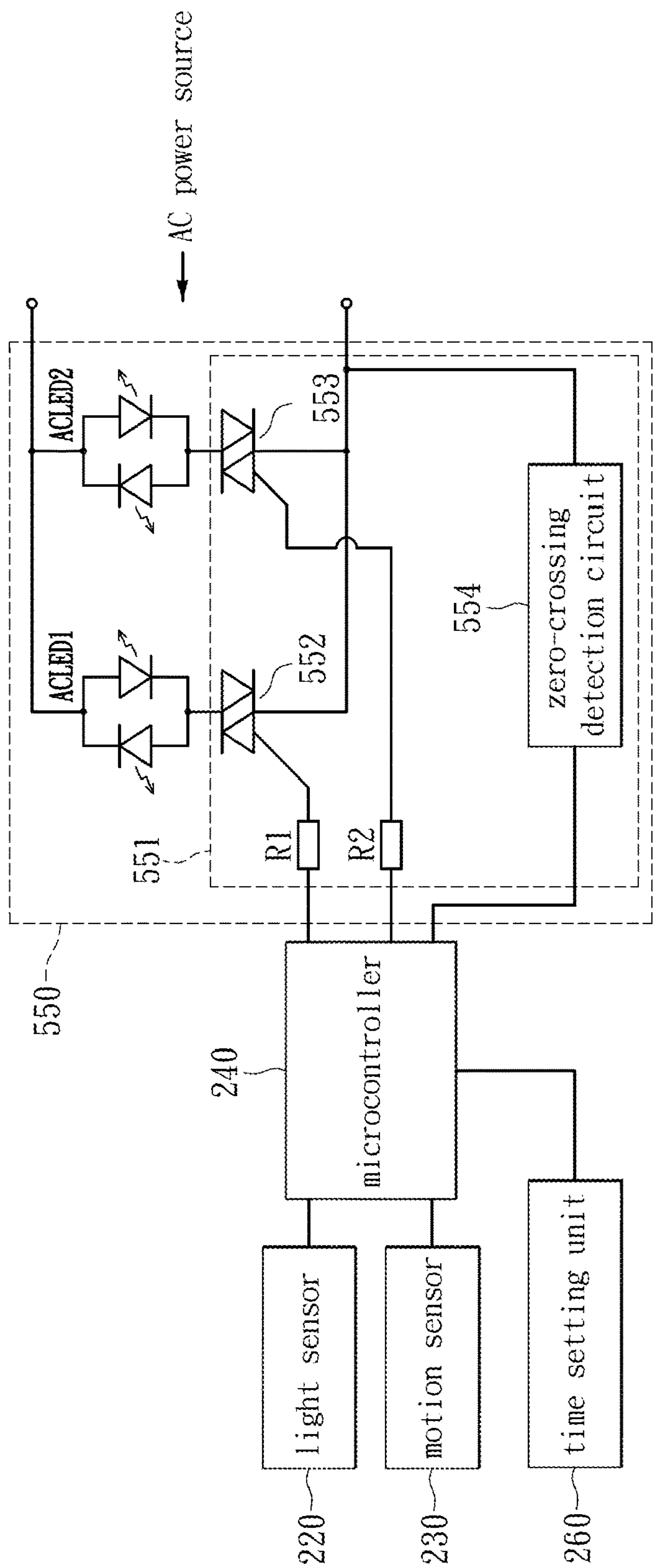

AC power source
ACLED2
ACLED1
553
552
554
zero-crossing detection circuit
551
R1
R2
550
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

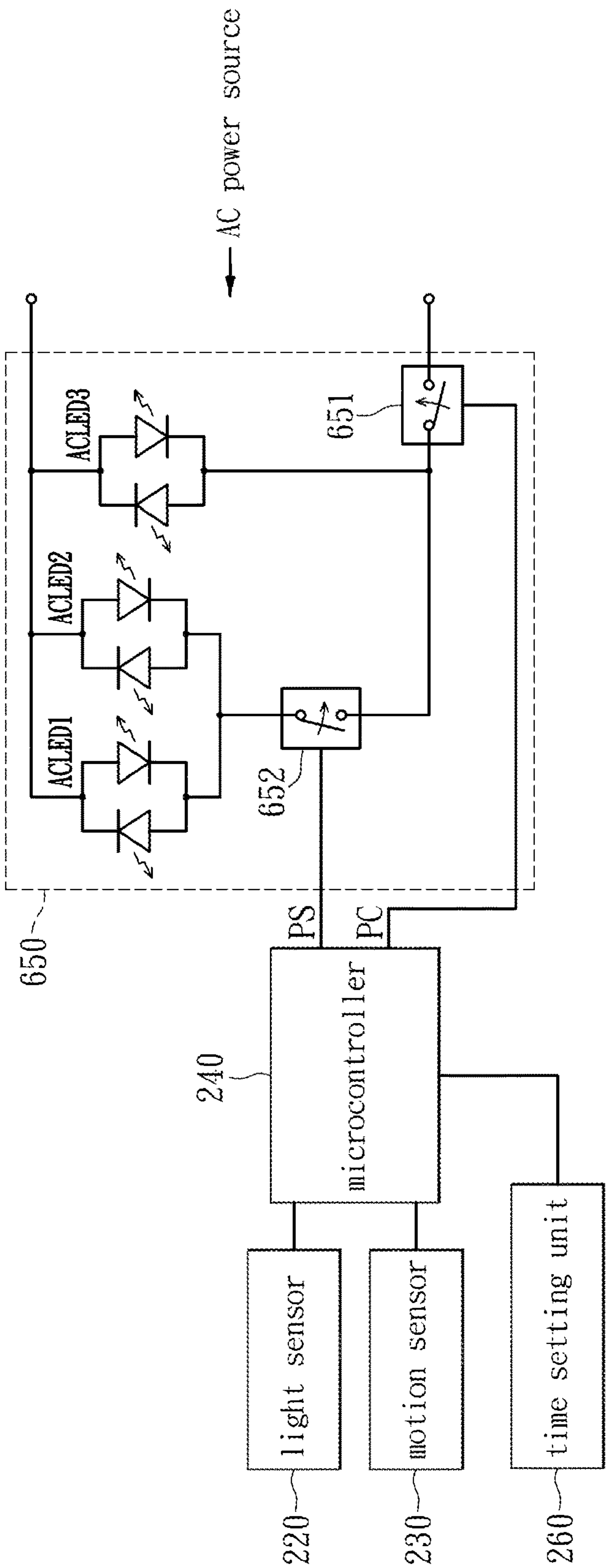

AC power source
ACLED3
ACLED2
ACLED1
651
652
650
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

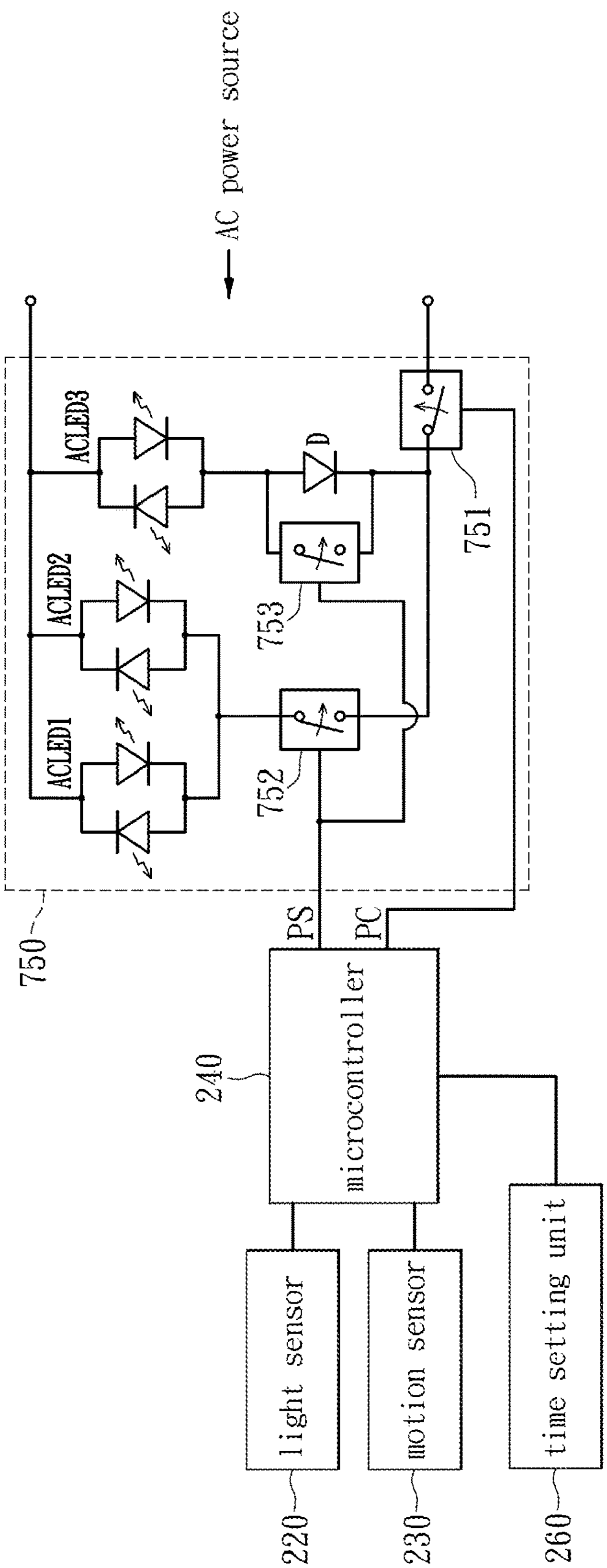

AC power source
ACLED3
ACLED2
ACLED1
D
751
753
752
750
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

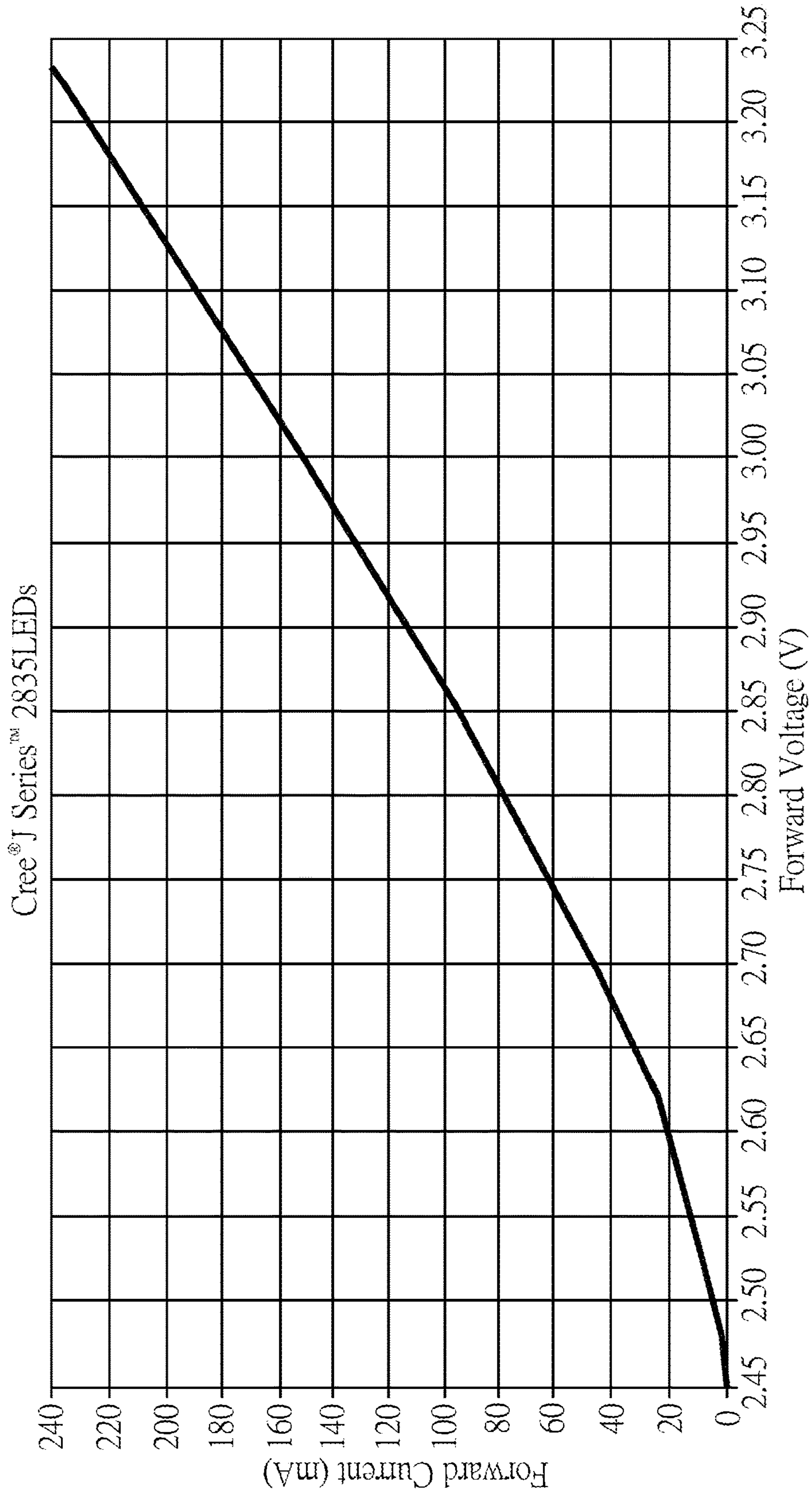

Cree® J Series™ 2835LEDs
Forward Current (mA)
0
20
40
60
80
100
120
140
160
180
200
220
240
Forward Voltage (V)
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25

FIG. 8A

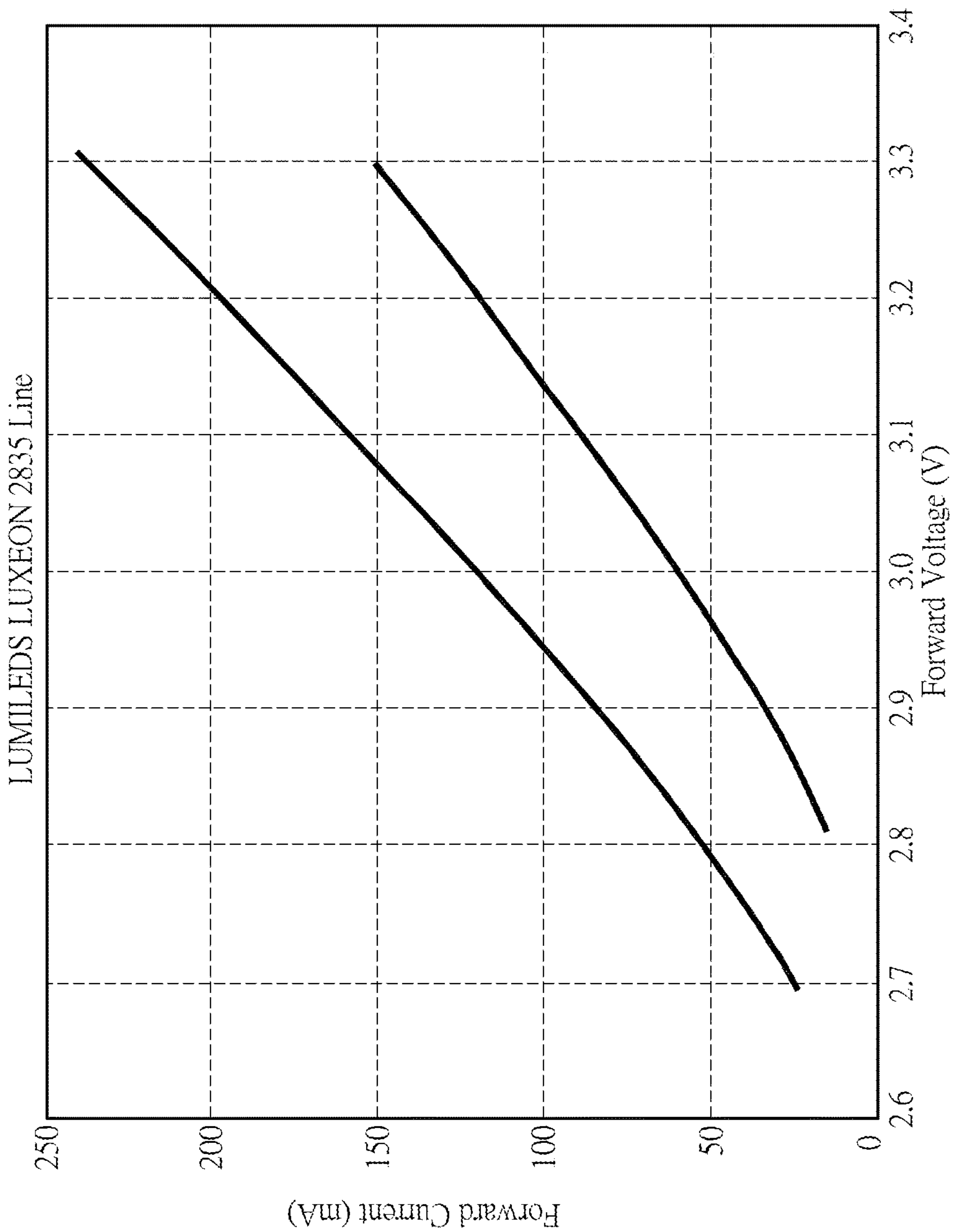

LUMILEDS LUXEON 2835 Line
Forward Current (mA)
250
200
150
100
50
0
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
Forward Voltage (V)

FIG. 8B

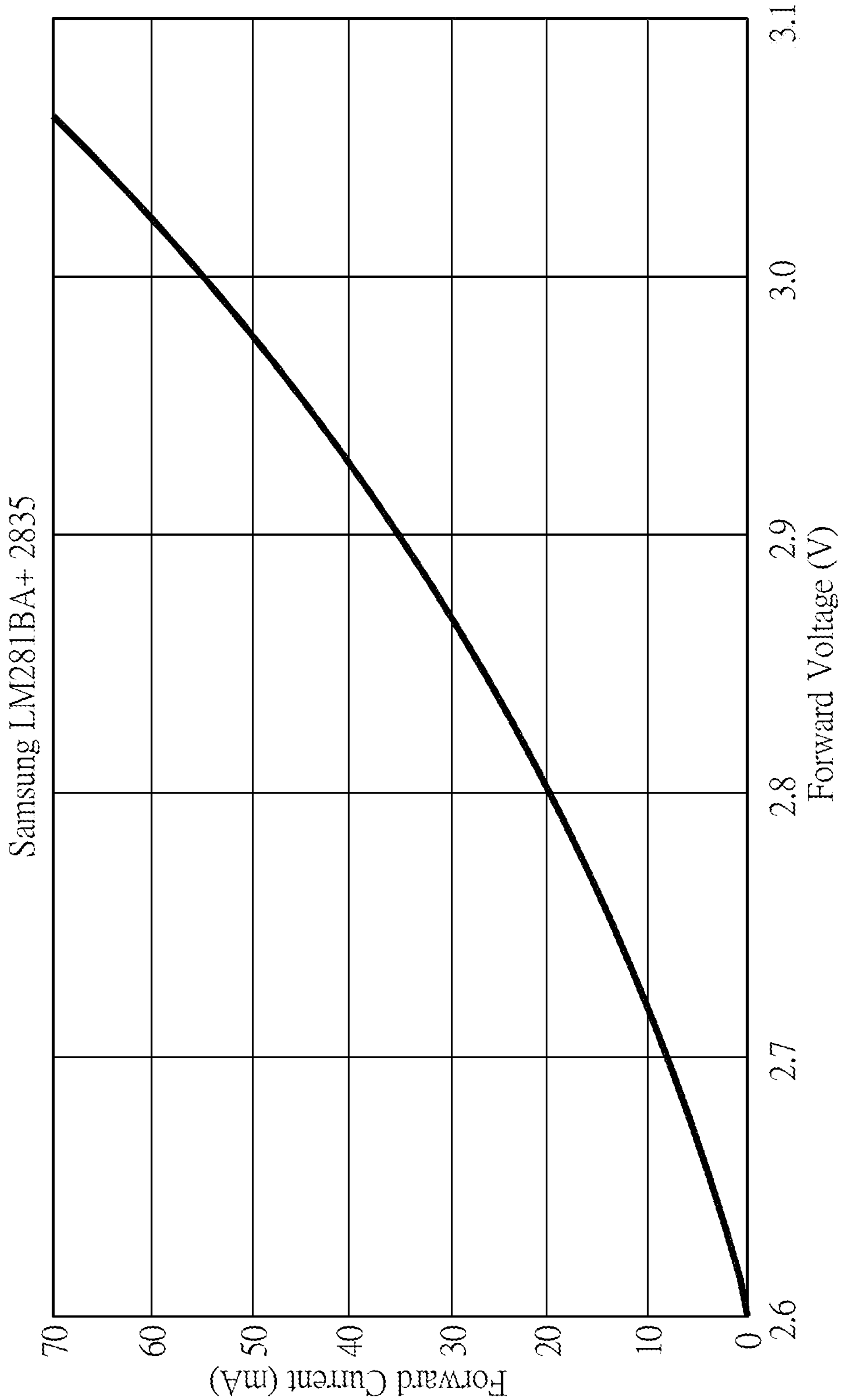

Samsung LM281BA+ 2835
Forward Current (mA)
0
10
20
30
40
50
60
70
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1

FIG. 8C

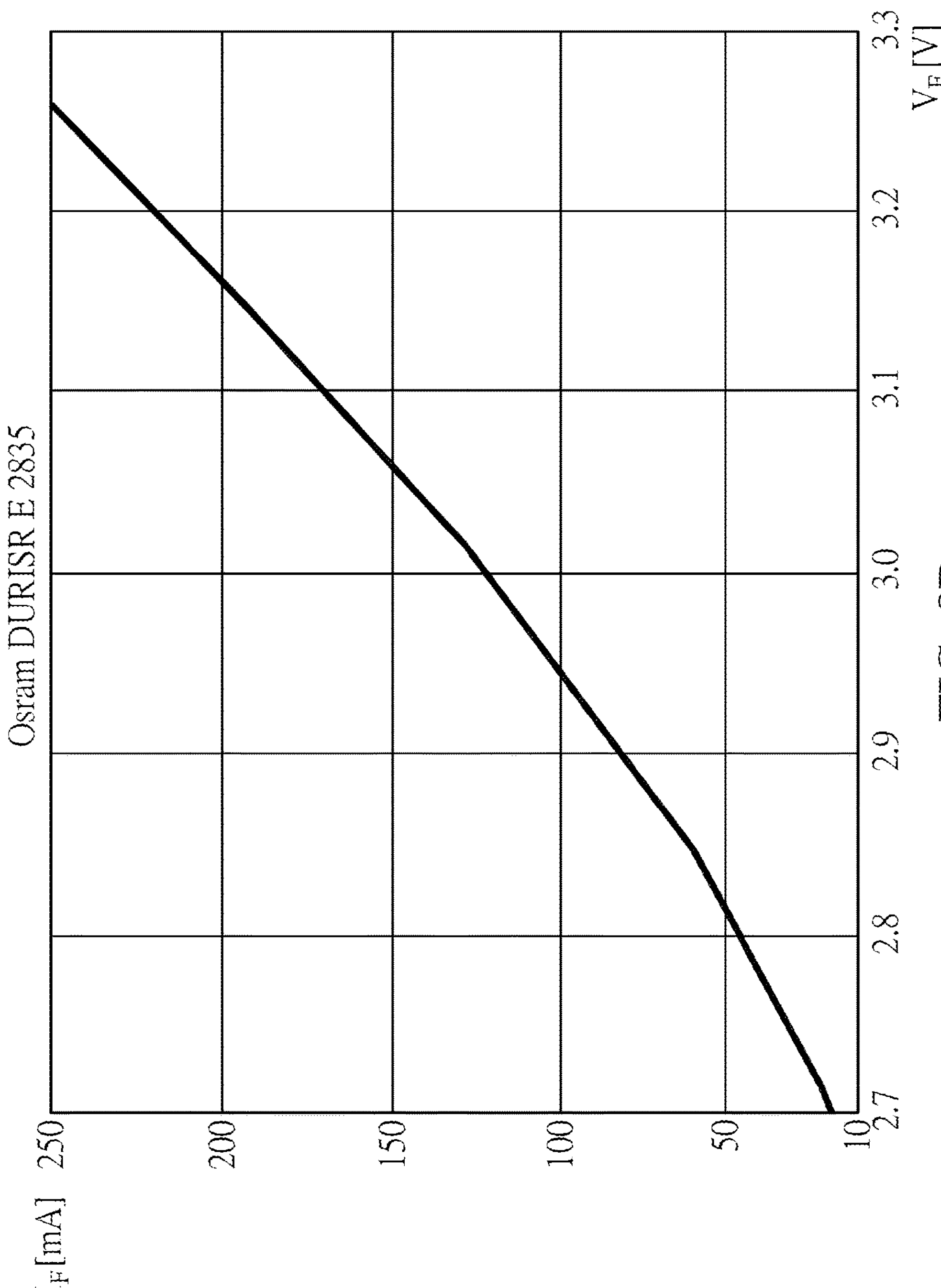

Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
2.7
2.8
2.9
3.0
3.1
3.2
3.3
V_F [V]

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

LIFE-STYLE LED SECURITY LIGHT

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation application of prior application Ser. No. 15/637,175 filed on Jun. 29, 2017, currently pending, which is a continuation application of prior application Ser. No. 15/230,752 filed on Aug. 8, 2016, issued as U.S. Pat. No. 9,743,480 on Aug. 22, 2017, which is a continuation application of prior application Ser. No. 14/478,150 filed on Sep. 5, 2014, issued as U.S. Pat. No. 9,445,474 on Sep. 13, 2016, which is a continuation application of prior application Ser. No. 13/222,090 filed on Aug. 31, 2011, issued as U.S. Pat. No. 8,866,392 on Oct. 21, 2014.

BACKGROUND

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor.

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photo resistors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power

supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes one or a plurality of parallel-connected alternating current (AC) LEDs. A phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher

than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto turn off at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediately switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy. The PC mode may alternatively generate the low level illumination to begin with and when the motion sensor is detected the disclosed LED security may immediately switch to a high level illumination for a short predetermined duration to provide security protection and then automatically return to the low level illumination.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an ACLED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the ACLED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C, and **8**D schematically and respectively show V-I relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. A

two-level LED security light (herein as the lighting apparatus) **100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller electrically coupled with a switching circuitry electrically connected between the light emitting unit **150** and the power supply unit **110**. The switching circuitry may comprise a plurality of semiconductor switching components. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that an ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode or it may alternatively generate the low level illumination to perform the power saving mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flows through the light-emitting unit **150**, to generate another high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240** electrically coupled to a switching circuitry **Q1**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein the DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a control signal like a pulse width modulation (PWM) signal to control an average electric current delivered to the light emitting unit **250**. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{on} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow a user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto. The time setting unit **260** may also be used for setting a predetermined time duration associated with the low level illumination as well as a predetermined time duration associated with a motion activated high level illumination. The time setting unit **260** is typically configured with an analogue circuitry comprising a resister and a capacitor for setting a time length. However, if precision of time length is crucial or much preferred, a digital circuitry may be employed, wherein a voltage divider with a variable resister coupled to the microcontroller designed with a time setting subroutine or a push button device coupled with a grounding pin of the microcontroller designed with the time setting subroutine for more precisely setting a time length for performing an illumination mode.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. **3**A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A and FIG. **2**A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** determines that an ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the

switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may be connected to a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include one or more parallel-connected alternating current (AC) LEDs. A phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** is connected to a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger

the triac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<½_f-t_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(½\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t(rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (½f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D, <6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall

in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLED and more than one bi-directional switching device. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1~3** having identical luminous power electrically connected to switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively

connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1~3** are coupled to the AC power source and the light-emitting unit **650** may generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED**3** is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ALCED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1~3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751~753** to render ACLED**1~3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs. In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

When the light source of the light emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of an operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a minimum threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the minimum threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the minimum threshold voltage and the maximum working voltage. In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as a minimum threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is a minimum threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned minimum threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the minimum threshold voltage into a corresponding time phase of AC power for lighting control, it is necessary to use the term V_{al} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V_{th} is the minimum threshold voltage to enable the LED chip to start emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working voltage of each single LED chip is required to operate in a domain between a minimum threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a minimum threshold voltage $N \times V_{th}$ and a maximum working voltage $N \times V_{max}$ or $N \times V_{th}<V<N \times V_{max}$ wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N \times V_{th}<V<N \times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises 4 drawings schematically and respectively showing a V-I relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage (the minimum threshold voltage or cut-in voltage) and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers.

The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry- and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer (Light of America) for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount of monetary relief was claimed with the Court in the complaint.

The present disclosure of a two-level LED security light provides a unique life-style lighting solution. The motivation of creating such life-style lighting solution has less to do with the energy saving aspect of the low level illumination mode because LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the life-style lighting solution of the present disclosure is featured with two innovations which meaningfully improve the exquisite tastes of living in the evening, the first innovation is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination which is necessary for creating a soft and aesthetic night scene for the outdoor living area (such soft and aesthetic night view is not achievable by the high level illumination however), the second innovation is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without getting lost or encountering an accident. These two innovative functions coupled with the motion sensor to increase illumination when people enters into the short detection area makes the present invention a perfect life-style lighting solution for enjoying an exquisite taste of evening life.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure

thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A life-style LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is turned on by the loading and power control unit activated by the light sensing control unit to perform a first illumination mode with a first level illumination and with the motion sensing unit being deactivated, and the first illumination mode continues for a first predetermined time duration;

wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to decrease the average electric current delivered to the LED load of the light-emitting unit to perform a second illumination mode with a second level illumination for a second predetermined time duration, and at the same time the motion sensing unit is activated;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to increase the average electric current delivered to the LED load of the light-emitting unit to perform a third illumination mode with a third level illumination for a third predetermined time duration before being switched back to the second illumination mode;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to switch off the light-emitting unit;

wherein the light intensity of the third illumination mode is higher than the light intensity of the second illumination mode;

wherein the time setting unit is used for adjusting and setting at least a time length of at least one of the first predetermined time duration, the second predetermined time duration and the third predetermined time duration;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the life-style LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with the power source from the power supply unit is configured with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

2. The life-style LED security light according to claim **1**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

3. The life-style LED security light according to claim **1**, wherein the control signals are pulse width modulation (PWM) signals.

4. The life-style LED security light according to claim **1**, wherein the first predetermined time duration is programmable by the time setting unit.

5. The life-style LED security light according to claim **1**, wherein the light intensity of the first illumination mode is adjustable by an external control unit.

6. The life-style LED security light according to claim **1**, wherein the time length of the second predetermined duration is set to end at dawn activated by the light sensing control unit.

7. The life-style LED security light according to claim **1**, wherein the second predetermined duration is programmable by the time setting unit.

8. The life-style LED security light according to claim **1**, wherein the light intensity of the second illumination mode is adjustable by an external control unit.

9. The life-style LED security light according to claim **1**, wherein the motion sensor is a passive infrared sensor.

10. The life-style LED security light according to claim **1**, wherein the motion sensor is a microwave motion sensor or an ultrasonic motion sensor.

11. A life-style LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is turned on by the loading and power control unit activated by the light sensing control unit to perform a first illumination mode with a first level illumination and with the motion sensing unit being in a deactivated state, and the first illumination mode continues for a first predetermined time duration;

wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to cutoff the average electric current delivered to the LED load of the light-emitting unit and at the same time the motion sensing unit is activated;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to deliver the average electric current to the LED load of the light-emitting unit to perform a second illumination mode with a second level illumination for a second predetermined time duration before being switched back to the turned off state;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is switched off by the loading and power control unit;

wherein the time setting unit is used for adjusting and setting at least a time length of at least one of the first predetermined time duration and the second predetermined time duration;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the life-style LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with the power source from the power supply unit is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

12. The life-style LED security light according to claim **11**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

13. The life-style LED security light according to claim **11**, wherein the control signals are pulse width modulation (PWM) signals.

14. The life-style LED security light according to claim **11**, wherein the time length of the first predetermined time duration is programmable by the time setting unit.

15. The life-style LED security light according to claim **11**, wherein the light intensity of the first illumination mode is adjustable by an external control unit.

16. The life-style LED security light according to claim **11**, wherein the time length of the second predetermined time duration is programmable by the time setting unit.

17. The life-style LED security light according to claim **11**, wherein the light intensity of the second illumination mode is adjustable by an external control unit.

18. The life-style LED security light according to claim **11**, wherein the motion sensor is a passive infrared sensor.

19. The life-style LED security light according to claim **11**, wherein the motion sensor is a microwave motion sensor or an ultrasonic motion sensor.

20. A life-style LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to turn on the light emitting unit to perform a low level illumination mode comprising at least a first level illumination for a first predetermined time duration;

wherein during the performance of the low level illumination mode, the low level illumination creates two life-style innovations for performing a life-style lighting solution, wherein a first innovation is the creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second innovation is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit operates to increase the average electric current delivered to the LED load of the light-emitting unit to perform a high level illumination mode for a preset time period before being switched back to the low level illumination mode;

wherein the light intensity of the high level illumination mode is higher than the light intensity of the low level illumination mode;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is switched off by the loading and power control unit;

wherein the time setting unit is used for adjusting and setting at least a time length of at least one of the first predetermined time duration of the low level illumination mode and the preset time period of the high level illumination mode;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the life-style LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

21. The life-style LED security light according to claim **20**, wherein the low level illumination mode further comprises a second level illumination;

wherein upon a maturity of the first predetermined time duration, the loading and power control unit operates to further reduce the light intensity of the low level illumination mode to perform the second level illumination to end at dawn activated by the light sensing control unit.

22. The life-style LED security light according to claim **21**, wherein the light intensity of the second level illumination is set at zero.

23. The life-style LED security light according to claim **21**, wherein the maturity of the first predetermined time duration is set to end at a midnight time point.

24. The life-style LED security light according to claim **20**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

25. The life-style LED security light according to claim **20**, wherein the control signals are pulse width modulation (PWM) signals.

26. The life-style LED security light according to claim **20**, wherein the motion sensor is a passive infrared sensor.

27. The life-style LED security light according to claim **20**, wherein the motion sensor is a microwave motion sensor or an ultrasonic motion sensor.

28. The life-style LED security light according to claim **20**, wherein the time length of the low level illumination mode is set to end at dawn activated by the light sensing control unit.

29. The life-style LED security light according to claim **20**, wherein the first predetermined time duration is programmable by the time setting unit.

30. The life-style LED security light according to claim **20**, wherein the time length of the preset time period is programmable by the time setting unit.

31. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes for respective predetermined time durations activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein the time setting unit is used for adjusting and setting at least a time length of the predetermined time durations;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the life-style LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

32. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the

light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the light-emitting unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit thru a soft on process, wherein the controller successively outputs a series of control signals to gradually increase the average electric current to drive the LED load of the light-emitting unit to generate a high level illumination, and the high level illumination continues for a predetermined time duration;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller.

33. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the light-emitting unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit to generate a high level illumination, the high level illumination continues for a predetermined time duration before the loading and power control unit manages to reduce illumination intensity of the light-emitting unit thru a soft off process, wherein the controller successively outputs a series of control signals to gradually decrease the average electric current to drive the LED load of the light-emitting unit such that the illumination intensity of the light-emitting unit is gradually reduced.

34. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on by the loading and power control unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit to perform a high level illumination for a predetermined time duration, wherein upon a maturity of the predetermined time duration the loading and power control unit manages to turn off the light-emitting unit that a soft off process, wherein the soft off process is designed with a two-stage approach;

wherein for the first stage of the soft off process, the loading and power control unit manages to instantly reduce the illumination level of the light-emitting unit to a low level illumination and continues the low level illumination for a first short time interval, wherein for the second stage of the soft off process the loading and power control unit operates to turn off the light-emitting unit.

35. The life-style LED security light according to claim **34**, wherein for the second stage of the soft off process the loading and power control unit operates to gradually turn off the illumination of the light-emitting unit over a second short time interval.

36. The life-style LED security light according to claim **34**, wherein during the soft off process if a new motion signal is further detected by the motion sensing unit indicating an occupant remaining in the detection area, the loading and power control unit instantly operates to restart a new cycle of the high level illumination for a new predetermined time duration;

wherein during the soft off a process if no further motion signal is received indicating the detection area is unoccupied, the light-emitting unit is thereby successfully turned, off.

37. The life-style LED security light according to claim **36**, wherein the new predetermined time duration is equal to the predetermined time duration used prior to restarting the new cycle of the high level illumination.

38. The life-style LED security light according to claim **36**, wherein the new predetermined time duration is programmed to be longer than the predetermined time duration used prior to restarting the new cycle of the high level illumination according to a programmed combination of increasing delay times.

39. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on by the loading and power control unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit to perform a high level illumination for a predetermined time duration, and upon a maturity of the predetermined time duration the loading and power control unit manages to turn off the light-emitting unit with a two-stage shutoff process;

wherein for the first stage of the shutoff process, the loading and power control unit manages to perform a sudden disruption of illumination for a short moment and resume instantly back to the high level illumination to continue for a first short time interval, wherein for the second stage of the shutoff process the loading and power control unit operates to gradually turn off the light-emitting unit over a second short time interval.

40. The life-style LED security light according to claim **39**, wherein during the two-stage shutoff process if a new motion signal is further detected by the motion sensing unit indicating an occupant remaining in the detection area, the loading and power control unit instantly manages to resume the high level illumination and restarts a new cycle of the high level illumination for a new predetermined time duration;

wherein during the two-stage shutoff process if no further motion signal is received indicating the detection area is unoccupied, the light-emitting unit is thereby successfully turned off.

41. The life-style LED security light according to claim **40**, wherein the time length of the new predetermined time duration is equal to the time length of the predetermined time duration.

42. The life-style LED security light according to claim **40**, wherein the time length of the new predetermined time duration is longer than the time length of the predetermined time duration according to a programmed combination of increasing delay times.

43. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on by the loading and power control unit to generate a low level illumination;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to increase the average electric current from the power source to the LED load of the light-emitting unit to generate a high level illumination for a predetermined time duration, wherein upon a maturity of the predetermined time duration the loading and power

control unit manages the light-emitting unit to resume the low level illumination, wherein if a new motion signal is further detected by the motion sensing unit within a short predetermined time interval after the light-emitting unit being switched back to the low level illumination, the loading and power control unit instantly manages to resume the high level illumination and restart a new cycle of illumination for a new predetermined time duration, wherein the time length of the new predetermined time duration is longer than the time length of the predetermined time duration according to a programmed combination of increasing delay times.

44. The life-style LED security light according to claim **31**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

45. The life-style LED security light according to claim **31**, wherein the control signals are pulse width modulation (PWM) signals.

46. The life-style LED security light according to claim **31**, wherein the motion sensor is a passive infrared sensor.

47. The life-style LED security light according to claim **31**, wherein the motion sensor is a microwave motion sensor or an ultrasonic motion sensor.

48. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing and control unit; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein with the switching circuitry the light-emitting unit is turned on or turned off by the loading and power control unit, and the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the light sensing control unit and the time setting unit;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is turned on by the loading and power control unit to perform a first illumination mode for a predetermined time duration set by the time setting unit, and then the controller manages to change the lighting performance of the LED security light from the first illumination mode to a second illumination mode;

wherein the light intensity of the second illumination mode is lower than the light intensity of the first illumination mode;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller;

wherein the time setting unit is used for adjusting and setting a time length of the predetermined time duration;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

49. The LED security light according to claim **48**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

50. The LED security light according to claim **48**, wherein the control signals are pulse width modulation (PWM) signals.

51. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit; and

a light sensing control unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the LED load of the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the controller of the loading and power control unit outputs a control signal to conduct the switching circuitry to deliver an average electric current to the LED load to turn on the light-emitting unit for generating an illumination;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the controller of the loading and power control unit outputs a control signal to cutoff the switching circuitry to turn off the light-emitting unit;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed, with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least an integrated circuit device programmable for generating the control signals or an application specific integrated circuit customized for generating the control signals.

52. The LED security light according to claim **51**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

53. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit; and

an external control unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the LED load of the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device, wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing at least a first illumination mode and a second illumination mode activated by the light sensing control unit and the external control unit;

wherein the external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal, wherein the controller controls the switching circuitry in response to the short power interruption signal detected to alternately switch the light-emitting unit between performing a first illumination mode and performing a second illumination mode, wherein the light intensity of the first illumination mode is higher than the light intensity of the second illumination mode;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is turned on, by the loading and power control unit to perform the first illumination mode; wherein whenever the short power interruption signal is detected by the external control unit, the controller operates to alternately switch the light-emitting unit between performing the first illumination mode and performing the second illumination mode;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the controller of the loading and power control unit operates to cutoff the switching circuitry to turn off the light-emitting unit;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a working voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least an integrated circuit device programmable for generating the control signals or an application specific integrated circuit customized for generating the control signals.

54. The LED security light according to claim **53**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

55. An LED motion sensing security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs a control signal to control the switching circuitry for transmitting an average electric current from the power source to drive the LED load of the light-emitting unit to generate an illumination activated by the motion sensing unit for performing a motion sensing illumination mode;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the light-emitting unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to conduct the switching circuitry to deliver the average electric current to drive the LED load for generating the illumination for a predetermined time duration preset by the time setting unit;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller.

56. The LED motion sensing security light according to claim **55**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

57. The LED security light according to claim **55**, wherein the control signal is pulse width modulation (PWM) signal.

58. The LED motion sensing security light according to claim **55**, wherein an external control unit is further installed and electrically coupled with the controller to receive and convert an external control signal into a message signal interpretable by the controller, wherein upon receiving the message signal the controller operates to activate a switching process to alternately perform among a high level non-motion sensing illumination mode, a low level non-motion sensing illumination mode and the motion sensing illumination mode.

59. The LED motion sensing security light according to claim **58**, wherein the external control unit is a short power interruption detection circuitry and the external control signal is an short power interruption signal, wherein when a first short power interruption signal is detected, the controller operates to change the performance of the light-emitting unit from the motion sensing illumination mode to the high level non-motion sensing illumination mode, wherein when a second short power interruption signal is furthered detected, the controller operates to change the performance of the light-emitting unit from the high level non-sensing illumination mode to the low level non-sensing illumination mode, wherein when a third short power interruption signal is further detected, the controller manages to change the performance of the light-emitting unit back to the motion sensing illumination mode to complete a cycle of the switching process.

60. The LED motion sensing security light according to claim **55**, wherein an external control unit is further installed and electrically coupled with the controller to receive and convert an external control signal into a message signal interpretable by the controller, wherein upon receiving the message signal the controller operates to activate a switching process to alternately perform between a low level non-motion sensing illumination mode and the motion sensing illumination mode.

61. The LED motion sensing security light according to claim **60**, wherein the external control unit is a short power interruption detection circuitry and the external control signal is a short power interruption signal, wherein when a first short power interruption signal is detected, the controller operates to change the performance of the light-emitting unit from the motion sensing illumination mode to the low level non-motion sensing illumination mode, wherein when a second short power interruption signal is furthered detected, the controller operates to change the performance of the light-emitting unit from the low level non-sensing illumination mode back to the motion sensing illumination mode to complete a cycle of the switching process.

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EXHIBIT C

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Chen

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(54) **LIFESTYLE SECURITY LIGHT**

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See application file for complete search history.

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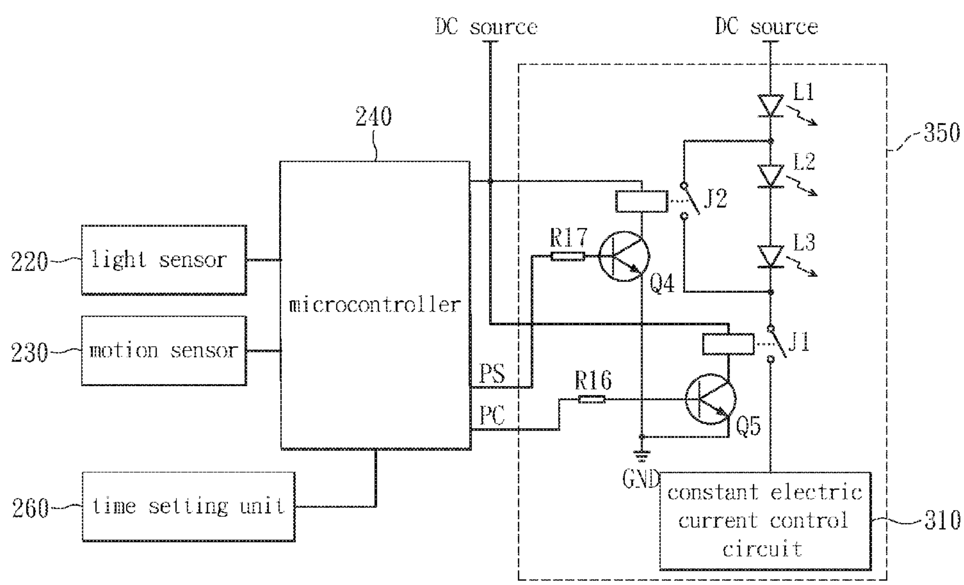
(57) **ABSTRACT**

A two-level LED security light includes a light-emitting unit comprising at least an LED load which may be turned on or turned off by a light sensing control unit. A motion sensing unit upon an intrusion detection activates the LED load to generate a high level illumination for a time length adjustable by a time setting unit. The LED load is operated in compliance with a power supply unit wherein a voltage V across each LED is confined in a range $V_{th}<V<V_{max}$, with V_{th} a threshold voltage and V_{max} a maximum voltage. The light-emitting unit may be configured with two LED lighting loads emitting lights with different color temperatures, wherein a power allocation circuitry may be installed to respectively distribute different electric powers to the two LED loads to manage a color temperature tuning scheme thru a light diffuser.

77 Claims, 16 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/637,175, filed on Jun. 29, 2017, now Pat. No. 10,165,643, which is a continuation of application No. 15/230,752, filed on Aug. 8, 2016, now Pat. No. 9,743,480, which is a continuation of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

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8,159,125	B2	4/2012	Miao	
8,194,061	B2	6/2012	Wang et al.	
8,288,953	B1 *	10/2012	Mei	H05B 33/0851 315/209 R
8,310,163	B2	11/2012	Chen	
8,325,040	B2	12/2012	Nassimi	
8,461,778	B2	6/2013	Mohan et al.	
8,476,836	B2	7/2013	Van De Ven et al.	
8,598,805	B2	12/2013	Tremblay et al.	
8,680,789	B2	3/2014	Mohan et al.	
8,901,825	B2	12/2014	Reed	
9,035,769	B2	5/2015	Steiner et al.	
9,271,345	B2	2/2016	Welten	
2005/0007025	A1	1/2005	Gauna	
2006/0022916	A1	2/2006	Aiello	
2007/0182338	A1	8/2007	Shteynberg et al.	
2007/0182347	A1	8/2007	Shteynberg et al.	
2008/0197783	A1	8/2008	Chen	
2008/0278934	A1	11/2008	Maldonado	
2008/0290822	A1 *	11/2008	Greene	H02J 17/00 315/363
2009/0189539	A1 *	7/2009	Deng	H05B 33/0812 315/294
2010/0141153	A1	6/2010	Recker et al.	
2011/0043133	A1	2/2011	Van Laanen et al.	
2012/0112677	A1	5/2012	Egger et al.	
2012/0206051	A1	8/2012	Nieuwlands	
2012/0262069	A1	10/2012	Reed	
2014/0062313	A1	3/2014	Ootsubo et al.	
2014/0210362	A1	7/2014	Shin et al.	
2015/0289339	A1	10/2015	Wu et al.	

* cited by examiner

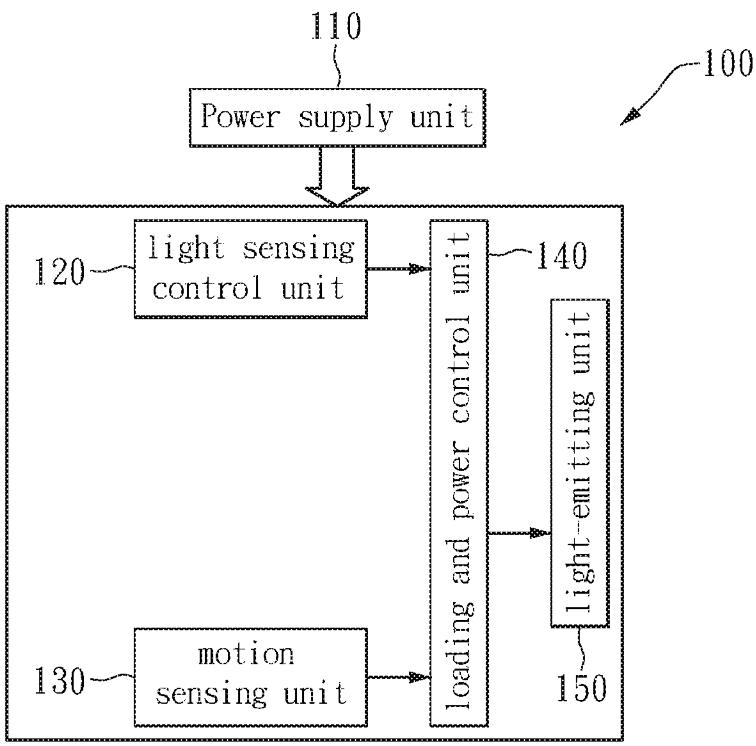
110
100
Power supply unit
120
light sensing control unit
loading and power control unit
140
light-emitting unit
130
motion sensing unit
150

FIG. 1

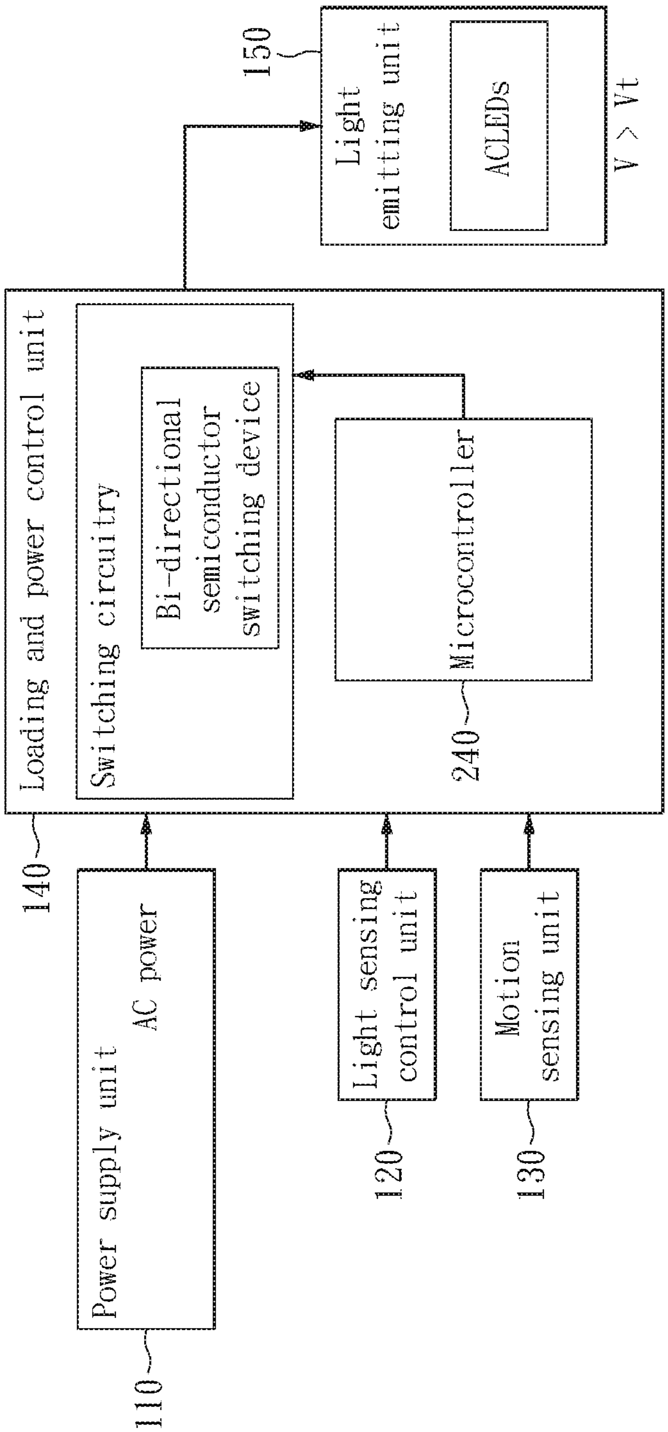
150
Light emitting unit
ACLEDs
V > Vt
Loading and power control unit
Switching circuitry
Bi-directional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
Light sensing control unit
Motion sensing unit
110
120
130

FIG. 1A

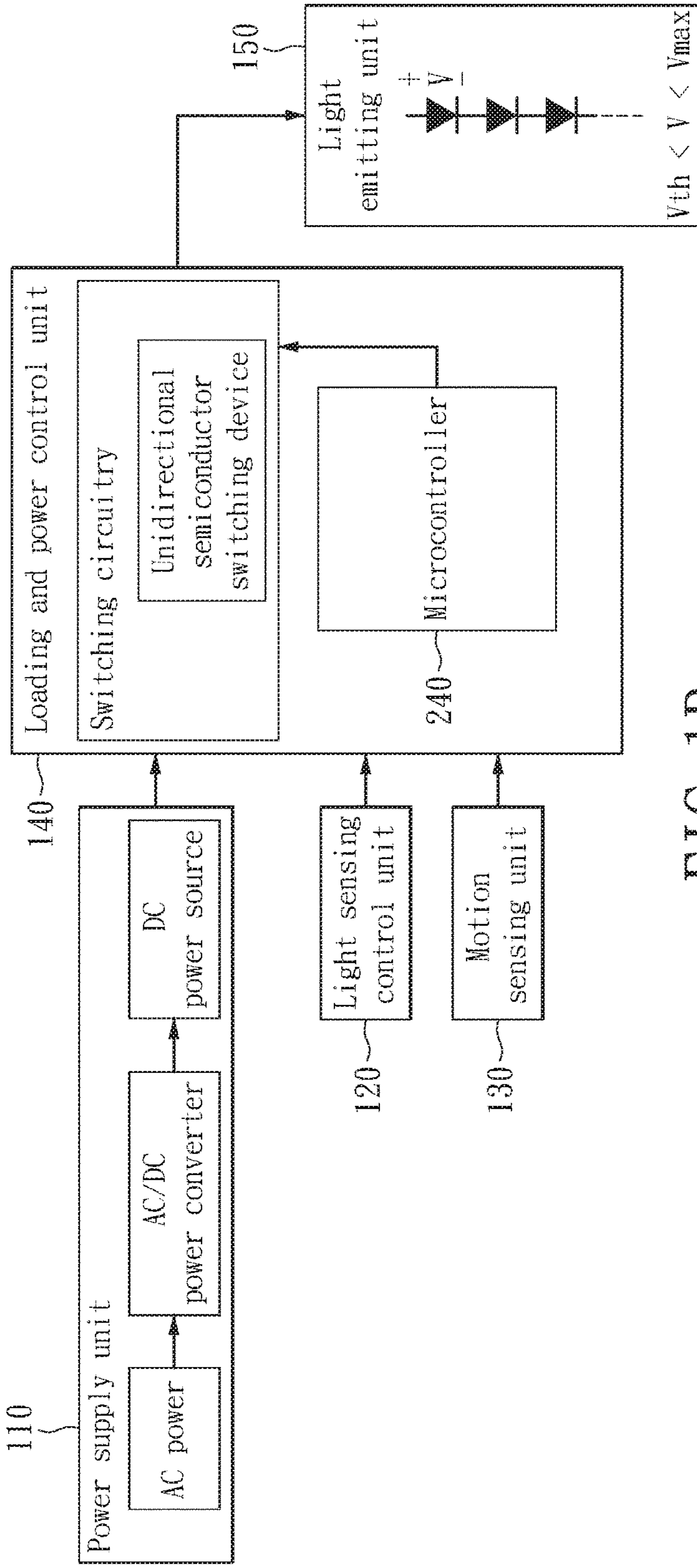
150
Light emitting unit
+ V −
Vth < V < Vmax
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
AC/DC power converter
DC power source
110
Light sensing control unit
120
Motion sensing unit
130

FIG. 1B

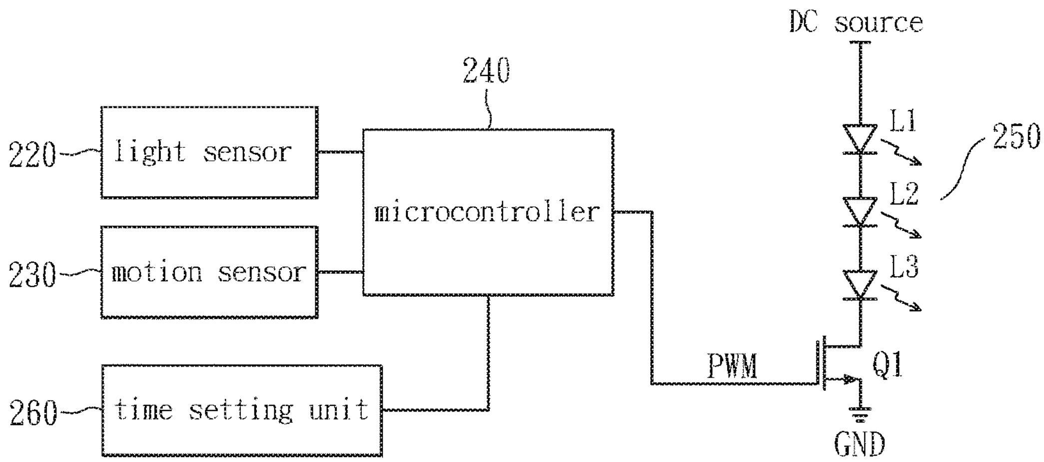
DC source
240
L1
250
220
light sensor
L2
microcontroller
L3
230
motion sensor
PWM
Q1
260
time setting unit
GND

FIG. 2A

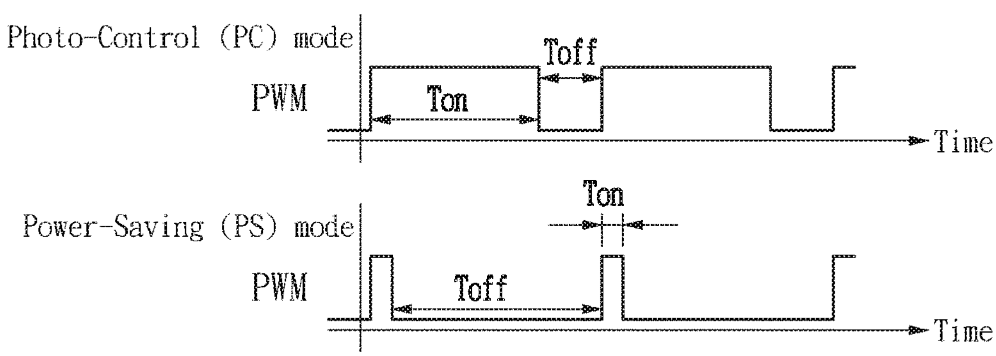
Photo-Control (PC) mode
Toff
PWM
Ton
Time
Power-Saving (PS) mode
Ton
PWM
Toff
Time

FIG. 2B

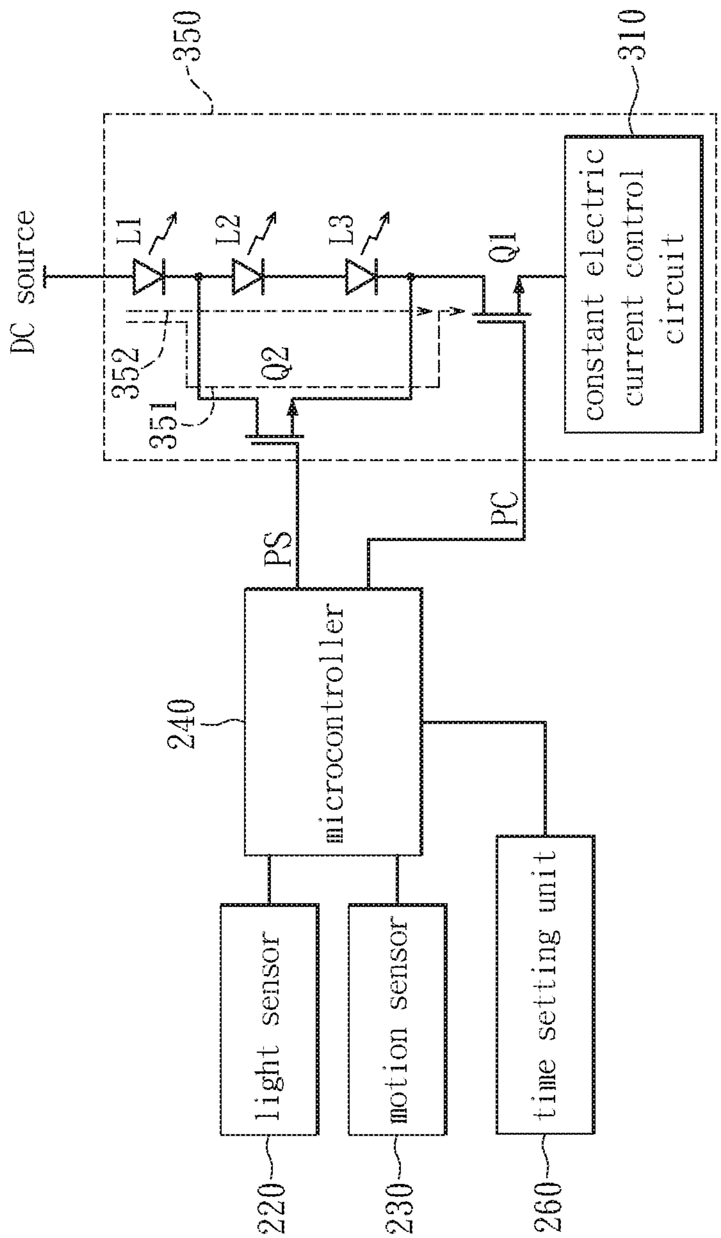
350
310
DC source
L1
L2
L3
Q1
352
351
Q2
constant electric current control circuit
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

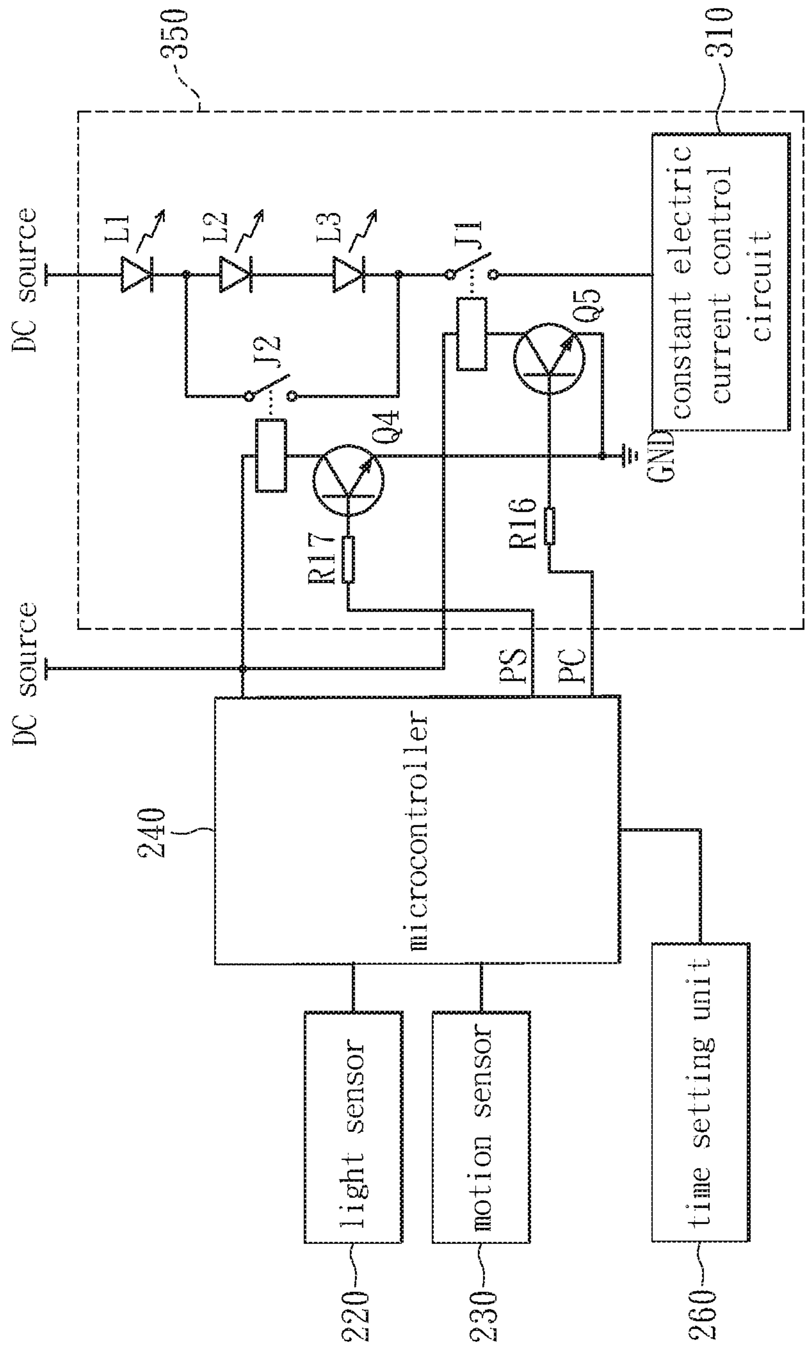
350
310
DC source
L1
L2
L3
J1
J2
Q4
Q5
R16
R17
GND
constant electric
current control
circuit
DC source
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

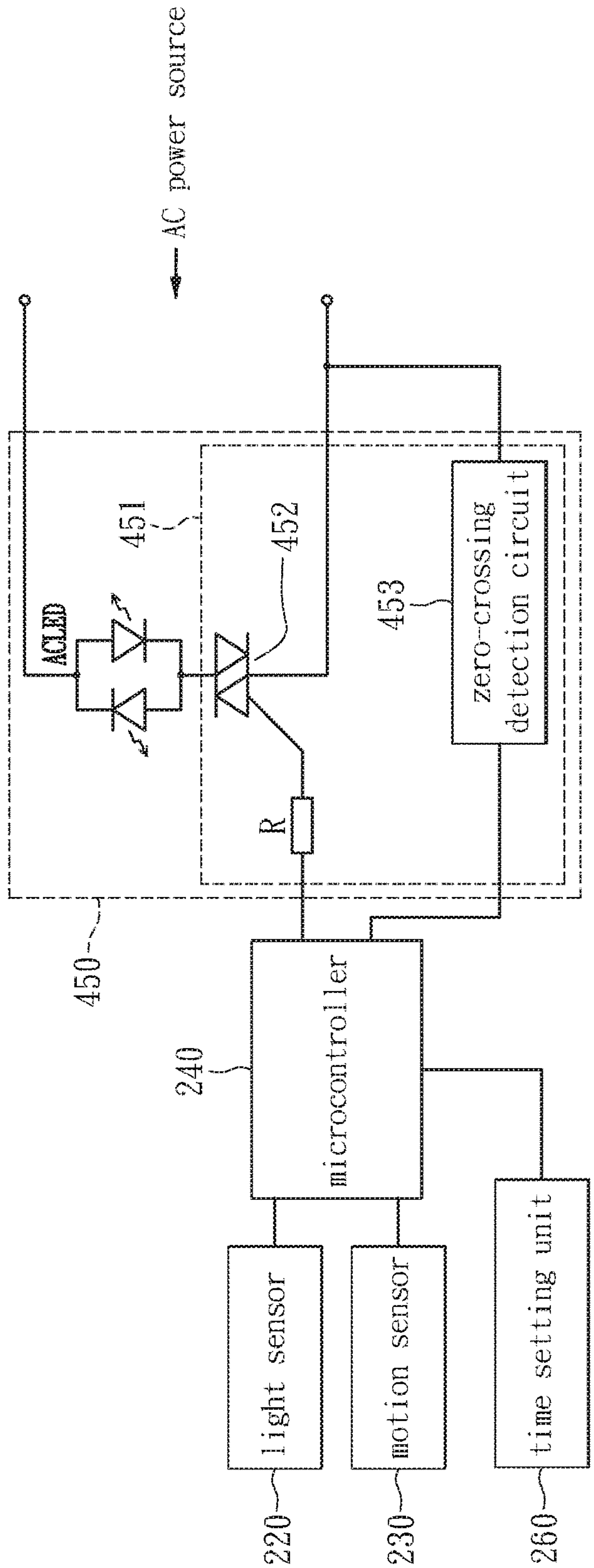
AC power source
ACLED
451
452
453
zero-crossing detection circuit
R
450
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

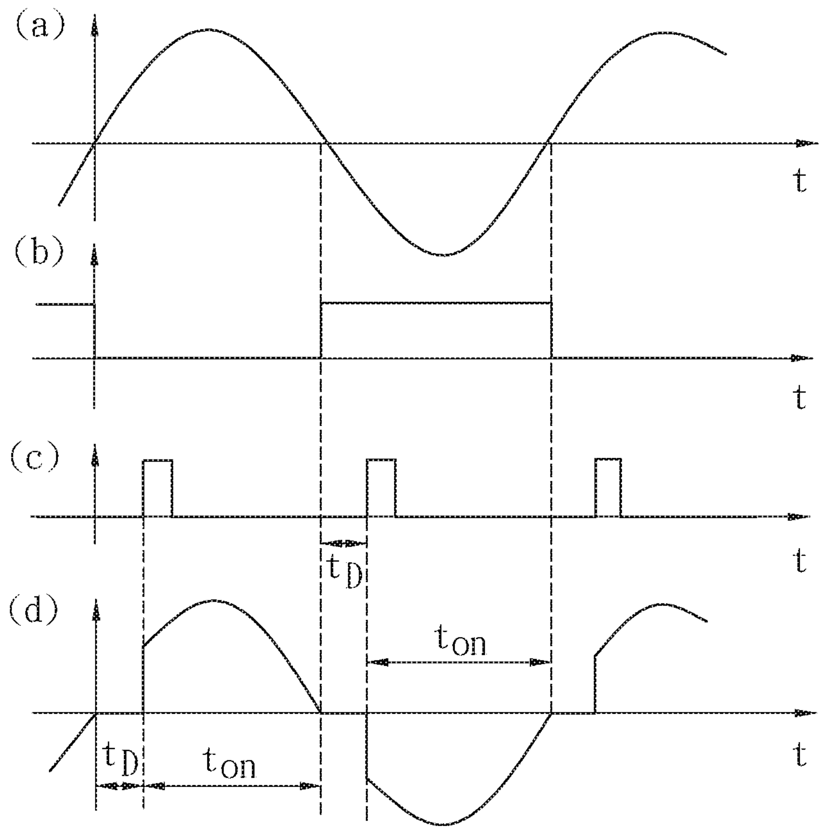

FIG. 4B

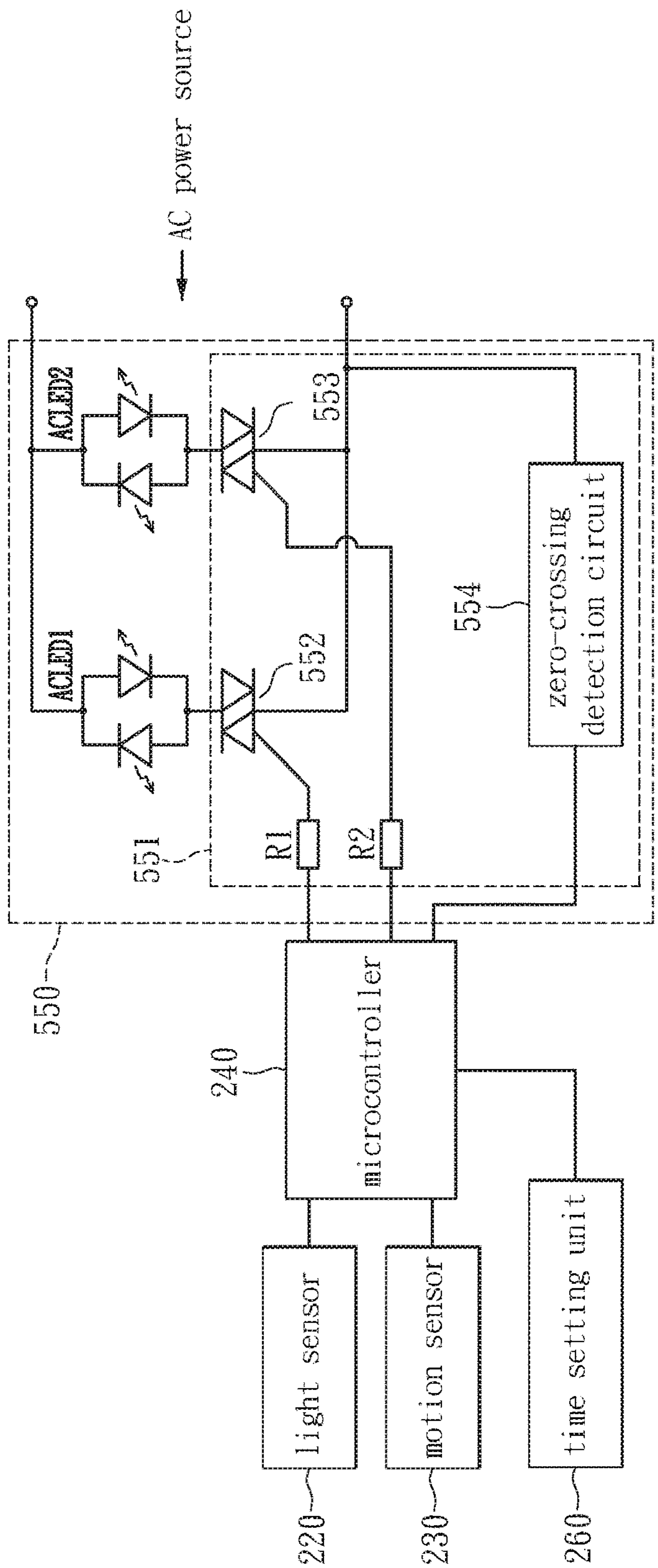
AC power source
ACLED2
ACLED1
553
552
551
554
zero-crossing detection circuit
R1
R2
550
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

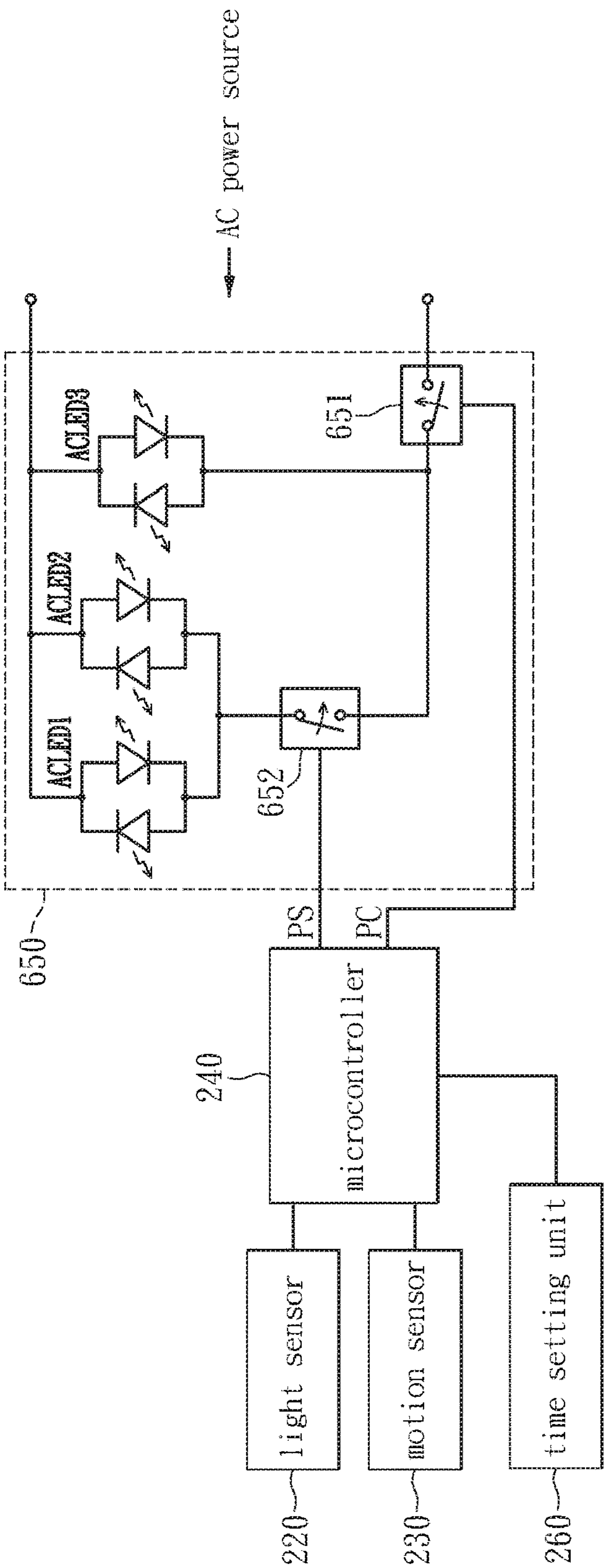
AC power source
ACLED3
ACLED2
ACLED1
651
652
650
PS
PC
microcontroller
240
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

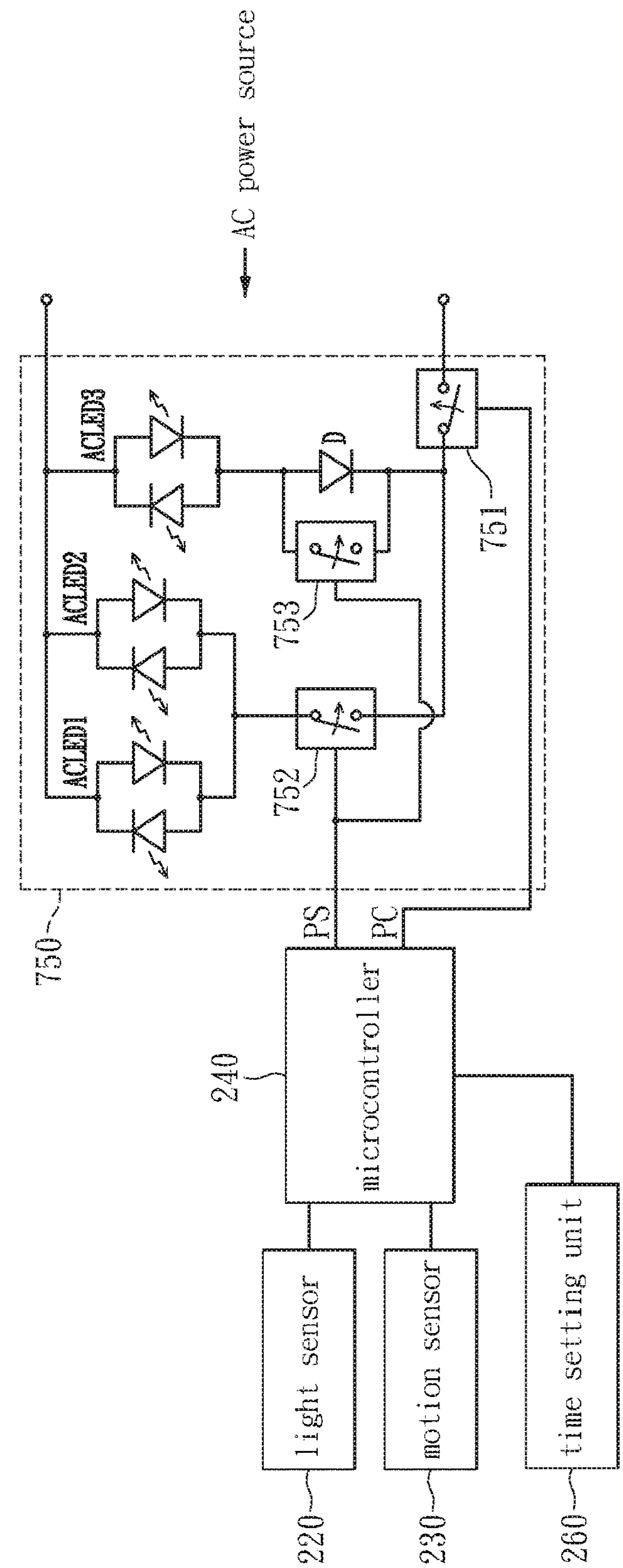
AC power source
ACLED1
ACLED2
ACLED3
D
751
752
753
750
PS
PC
microcontroller
240
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

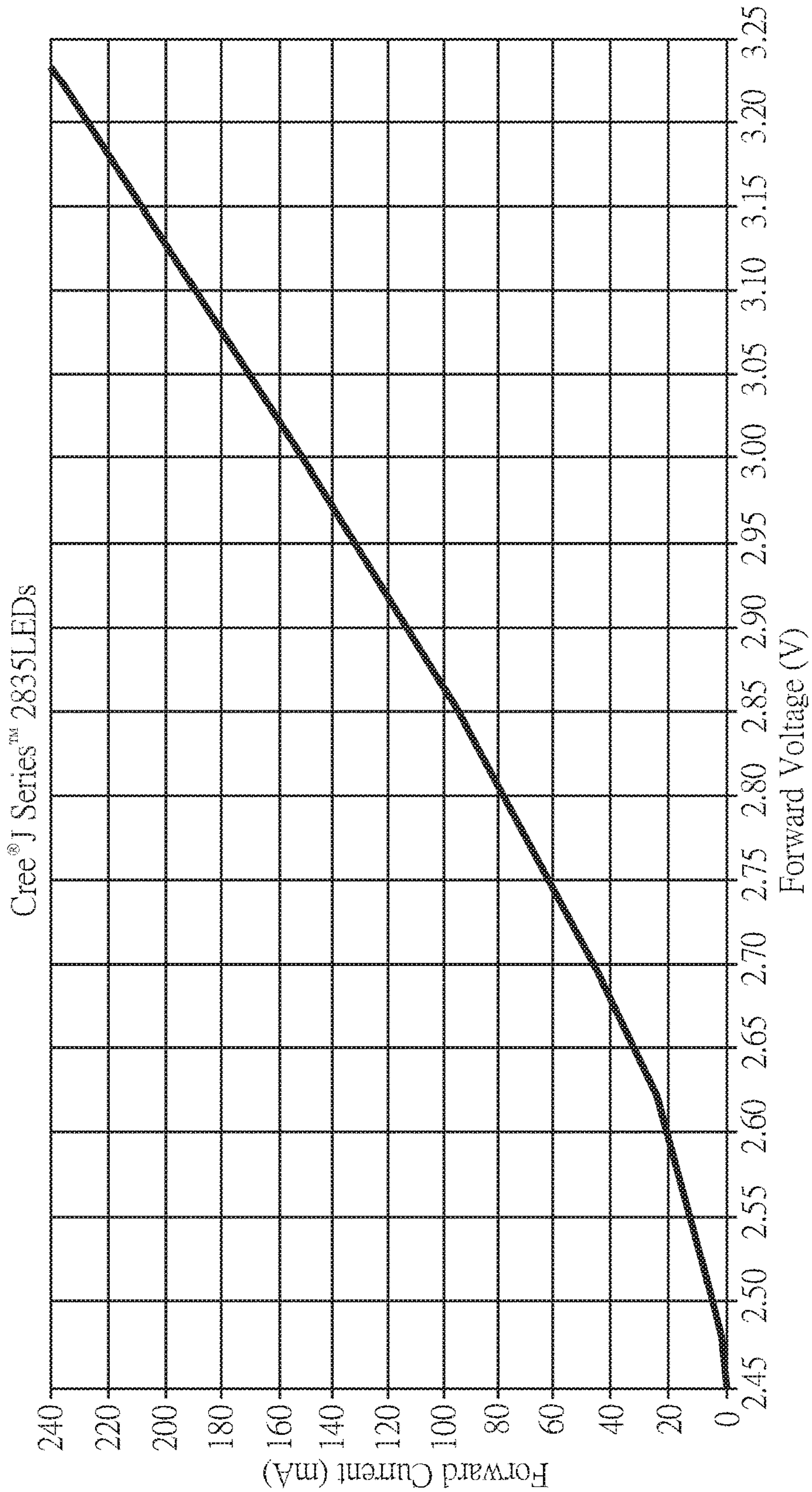
Cree® J Series™ 2835LEDs
Forward Current (mA)
240
220
200
180
160
140
120
100
80
60
40
20
0
Forward Voltage (V)
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25

FIG. 8A

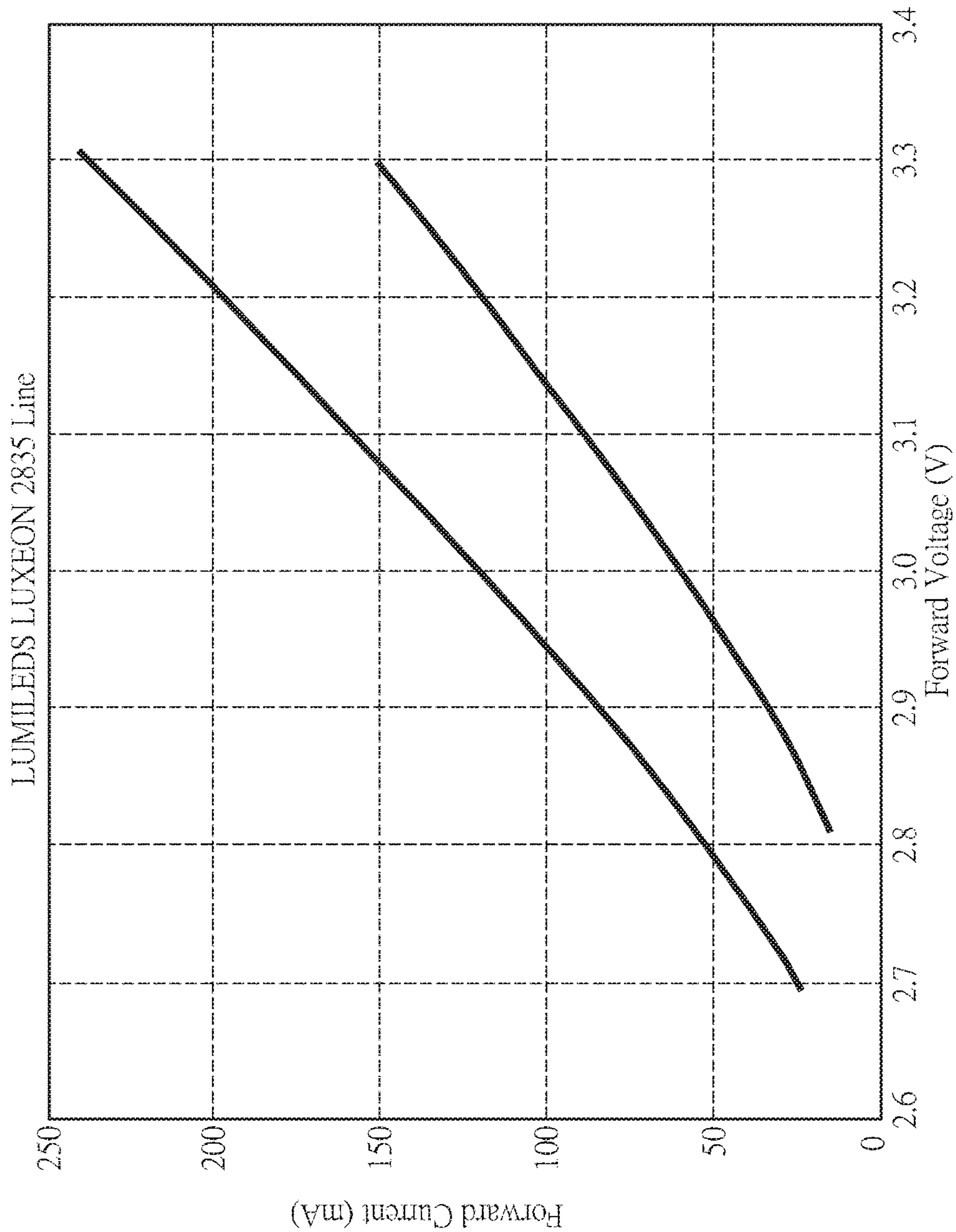
LUMILEDS LUXEON 2835 Line
Forward Current (mA)
250
200
150
100
50
0
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
Forward Voltage (V)

FIG. 8B

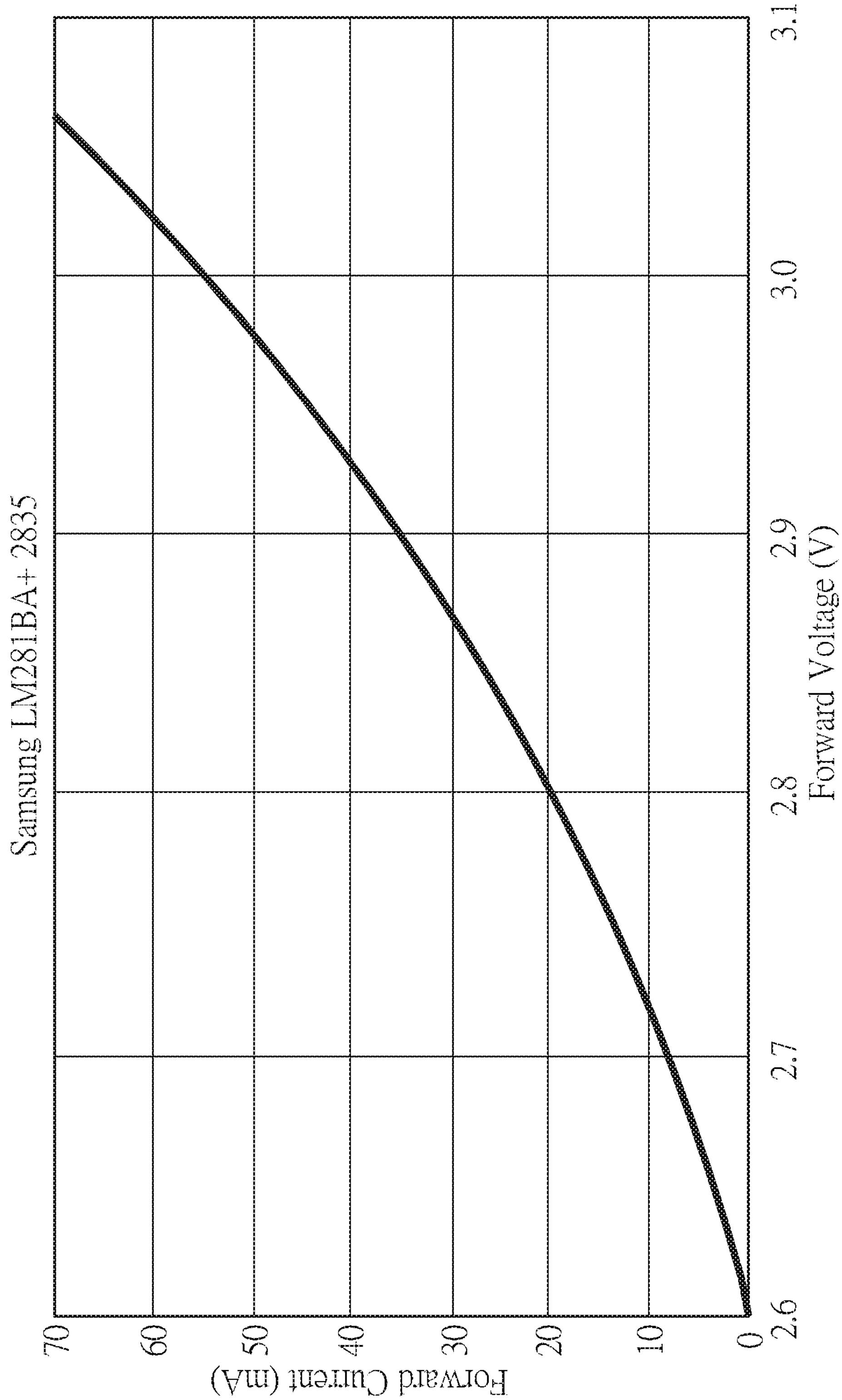
Samsung LM281BA+ 2835
Forward Current (mA)
0
10
20
30
40
50
60
70
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1

FIG. 8C

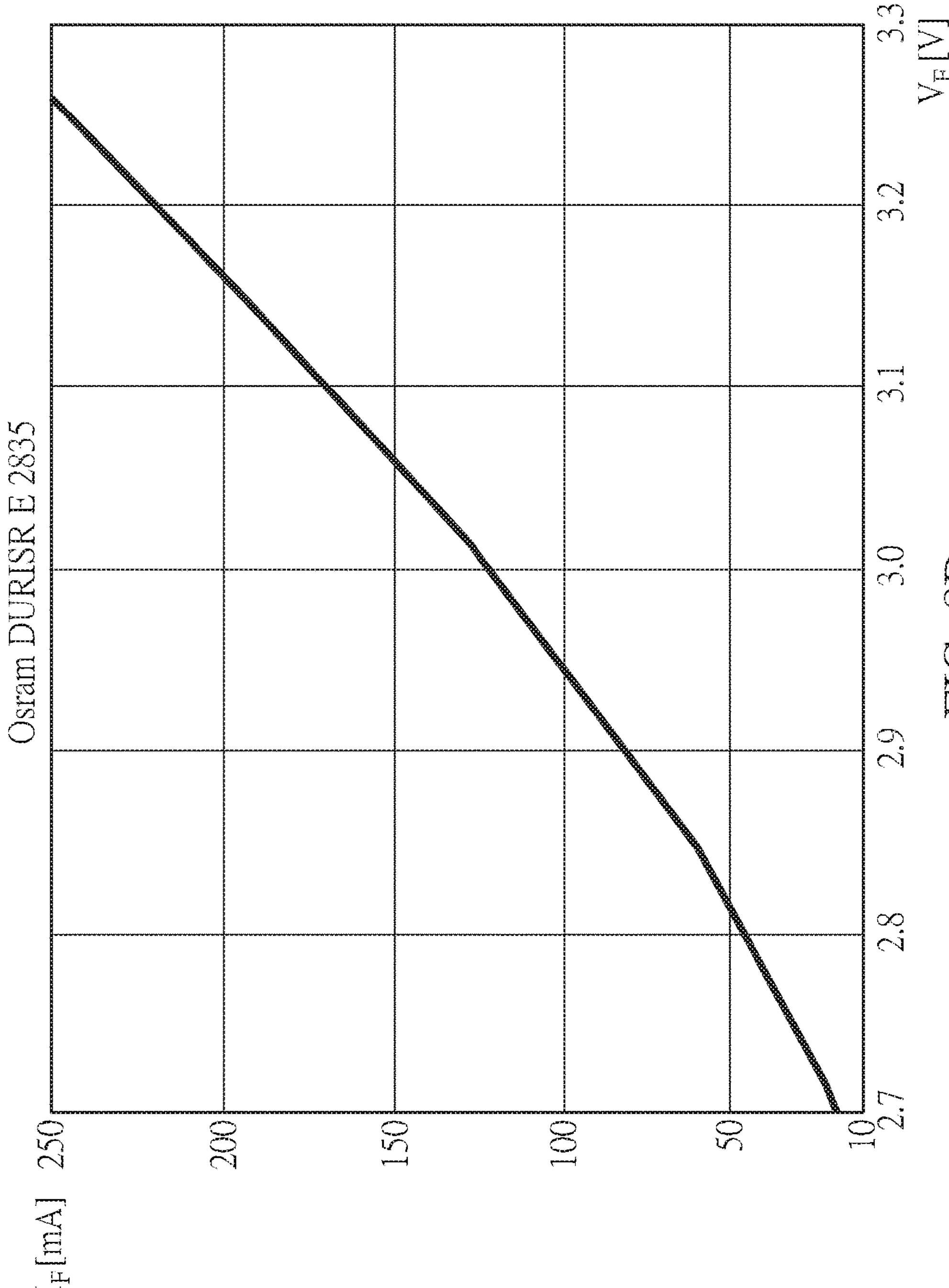
Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
2.7
2.8
2.9
3.0
3.1
3.2
3.3
V_F [V]

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

LIFESTYLE SECURITY LIGHT

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation application of prior application Ser. No. 15/856,468 filed on Dec. 28, 2017, currently pending, which is a continuation application of prior application Ser. No. 15/637,175 filed on Jun. 29, 2017, currently pending, which is a continuation application of prior application Ser. No. 15/230,752 filed on Aug. 8, 2016, issued as U.S. Pat. No. 9,743,480 on Aug. 22, 2017, which is a continuation application of prior application Ser. No. 14/478,150 filed on Sep. 5, 2014, issued as U.S. Pat. No. 9,445,474 on Sep. 13, 2016, which is a continuation application of prior application Ser. No. 13/222,090 filed on Aug. 31, 2011, issued as U.S. Pat. No. 8,866,392 on Oct. 21, 2014.

BACKGROUND

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor.

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photo resistors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes one or a plurality of parallel-connected alternating current (AC) LEDs. A phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage

ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto turn off at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediately switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy. The PC mode may alternatively generate the low level illumination to begin with and when the motion sensor is detected the disclosed LED security may immediately switch to a high level illumination for a short predetermined duration to provide security protection and then automatically return to the low level illumination.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an ACLED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the ACLED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C and **8**D schematically and respectively show V-I relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to

the first exemplary embodiment of the present disclosure. A two-level LED security light (herein as the lighting apparatus) **100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller electrically coupled with a switching circuitry electrically connected between the light-emitting unit **150** and the power supply unit **110**. The switching circuitry may comprise a plurality of semiconductor switching components. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that an ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode or it may alternatively generate the low level illumination to perform the power saving mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flows through the light-emitting unit **150**, to generate another high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240** electrically coupled to a switching circuitry Q**1**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein the DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a control signal like a pulse width modulation (PWM) signal to control an average electric current delivered to the light-emitting unit **250**. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{on} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow a user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto. The time setting unit **260** may also be used for setting a predetermined time duration associated with the low level illumination as well as a predetermined time duration associated with a motion activated high level illumination. The time setting unit **260** is typically configured with an analogue circuitry comprising a resister and a capacitor for setting a time length. However, if precision of time length is crucial or much preferred, a digital circuitry may be employed, wherein a voltage divider with a variable resister coupled to the microcontroller designed with a time setting subroutine or a push button device coupled with a grounding pin of the microcontroller designed with the time setting subroutine for more precisely setting a time length for performing an illumination mode.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. **3**A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A and FIG. **2**A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** determines that an ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the

switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may be connected to a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include one or more parallel-connected alternating current (AC) LEDs. A phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** is connected to a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger

the triac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<1/2\ f-t_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(1/2\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t(rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (1/2f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D<6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLED and more than one bi-directional switching device. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1**~**3** having identical luminous power electrically connected to switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively

connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1**~**3** are coupled to the AC power source and the light-emitting unit **650** may generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED**3** is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ACLED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1**~**3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751**~**753** to render ACLED**1**~**3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs.

In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

When the light source of the light-emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of an operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a minimum threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the minimum threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the minimum threshold voltage and the maximum working voltage. In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as a minimum threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is a minimum threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned minimum threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the minimum threshold voltage into a corresponding time phase of AC power for lighting control, it is necessary to use the term V_{th} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V_{th} is the minimum threshold voltage to enable the LED chip to start emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working voltage of each single LED chip is required to operate in a domain between a minimum threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a minimum threshold voltage $N \times V_{th}$ and a maximum working voltage $N \times V_{max}$ or $N \times V_{th}<V<N \times V_{max}$, wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N \times V_{th}<V<N \times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises 4 drawings schematically and respectively showing a V-I relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage (the minimum threshold voltage or cut-in voltage) and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers.

The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer (Light of America) for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount of monetary relief was claimed with the Court in the complaint.

The present disclosure of a lifestyle security light provides a unique lifestyle lighting solution. The motivation of creating such lifestyle lighting solution has less to do with the energy saving aspect of the low level illumination mode because LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the lifestyle lighting solution of the present disclosure is featured with at least three innovative advantages which meaningfully improve the exquisite tastes of living in the evening, the first innovative advantage is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination which is necessary for creating a soft and aesthetic night scene for the outdoor living area, such soft and aesthetic night scene is not achievable by the high level illumination, the second innovative advantage is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without getting lost or encountering an accident, the third innovative advantage is a prevention of the light being unexpectedly and completely shutoff while a person is still in the detection area and a simple motion can bring the light back to the full illumination. These three innovative functions coupled with the motion sensor to increase illumination when people enters into the short detection area makes the present invention a perfect lifestyle lighting solution for enjoying an exquisite taste of evening life.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide

the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A lifestyle LED security light, comprising:

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the LED load of the light-emitting unit, wherein the LED load is switched on or switched off by the light sensing control unit and controlled by the loading and power control unit, wherein the switching circuitry comprises at least a semiconductor switching device for controlling transmission of different electric powers delivered to the LED load, wherein the controller outputs control signals to control the switching circuitry for delivering different electric powers from the power source to drive the light-emitting unit for generating different illuminations characterized by different light intensities according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power source configured in the power supply unit outputs a DC power for operating the LED lighting device;

wherein a time setting unit is further installed and is electrically coupled with the controller for adjusting and setting a time duration for each of the different illumination modes, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the LED load to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to increase the electric power transmitted to the LED load to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein the light intensity of the second level illumination is higher than the light intensity of the first level illumination, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to switch off the LED load;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during the performance of the first illumination mode, the low level illumination creates four advantages for performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein a third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff while a person is still in the detection space due to expiration of a timer and a simple motion by the person can immediately bring the LED security light back to the high level illumination, wherein a fourth advantage is an occupancy declaration that a living space being occupied to discourage an intrusion or break in intention.

2. The lifestyle LED security light according to claim 1, wherein a configuration of the plurality of LEDs of the light emitting unit is designed with a combination of in series and/or in parallel connections such that when incorporated with a level setting of the DC power from the switching circuitry, an electric current passing through each LED of the LED load remains at a safety level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when the LED load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<N_N<N\times V_{max}$.

3. The lifestyle LED security light according to claim 2, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the LED load is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

4. The lifestyle LED security light according to claim 1, wherein the power supply unit is configured with an AC/DC power converter to convert an AC power into a least one DC power required for operating the LED security light.

5. The lifestyle LED security light according to claim 1, wherein the power supply unit comprises a battery module to output at least one DC power for operating the lifestyle LED security light.

6. The lifestyle LED security light according to claim 5, wherein the battery module is a rechargeable battery module.

7. The lifestyle LED security light according to claim 6, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

8. A lifestyle LED security light control device, comprising:

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the LED security light control device is electrically connectable to an LED load configured with a plurality of LEDs, wherein the loading and power control unit comprises a controller and a switching

circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the LED load, wherein the switching circuitry comprises at least a semiconductor switching device for controlling transmission of different electric powers delivered to the LED load, wherein the controller outputs control signals to control the switching circuitry for delivering different electric powers from the power source to drive the LED load for performing at least two different illumination modes with different light intensities according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power source configured in the power supply unit outputs at least one DC power for operating the LED lighting device;

wherein a time setting unit is further installed and is electrically coupled with the controller for adjusting and setting a time duration for each of the different illumination modes, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to turn on the LED load to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to increase the average electric power transmitted to the LED load to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein the light intensity of said second level illumination is higher than the light intensity of said first level illumination, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to turn off the LED load;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during the performance of the first illumination mode, the low level illumination creates four advantages in performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein the third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff due to expiration of a timer while a person is still in a detection space and a simple motion by the person can immediately bring the LED load back to the high level illumination, wherein a fourth advantage is an occupancy declaration that a living space being occupied to discourage an intrusion or break in intention.

9. The lifestyle LED security light control device according to claim **8**, wherein the plurality of LEDs are designed with a configuration of in series and/or in parallel connections such that when incorporated with a level setting of the DC power from the switching circuitry, an electric current passing through each LED of the LED load remains at a safety level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when the LED load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

10. The lifestyle LED security light according to claim **9**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the LED load is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

11. The lifestyle LED security light control device according to claim **8**, wherein the controller is an integrated circuit device programmable for generating the control signal.

12. The lifestyle LED security light control device according claim **8**, wherein the controller is an application specific integrated circuit customized for generating the control signal.

13. The lifestyle LED security light control device according to claim **8**, wherein the power supply unit comprises a battery module to output at least one DC power for operating the LED security light.

14. The lifestyle LED security light control device according to claim **13**, wherein the battery module is a rechargeable battery module.

15. The lifestyle LED security light control device according to claim **14**, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

16. A lifestyle LED security light, comprising:

a light-emitting unit, including a dimmable LED bulb;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the dimmable LED bulb of the light-emitting unit, wherein the switching circuitry comprises at least a semiconductor switching device for controlling transmission of different average electric powers delivered to the dimmable LED bulb, wherein the controller outputs control signals to control the switching circuitry for delivering different average electric powers from the power source to drive the dimmable LED bulb of the light-emitting unit for generating different illuminations with different light intensities according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power supply unit includes an AC/DC power converter to convert an AC power of an AC power source into a DC power for operating the LED security light, wherein the power source is the AC power, wherein the semiconductor switching device is a phase controller containing a bidirectional semiconductor switching device, wherein the control signal is a time

delay pulse to control a conduction state of the bidirectional semiconductor switching device in each half cycle of the AC power, wherein the controller incorporating with a zero-crossing detection circuit outputs a time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power source to control a conduction rate of the phase controller for delivering different average electric powers to drive the dimmable LED bulb for performing different illumination modes according to signals received from the light sensing control unit and the motion sensing unit, wherein in order to ensure a successful conduction of the dimmable LED bulb the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage at which the dimmable LED bulb starts to emit light in each positive and negative half cycle of the AC power;

wherein a time setting unit is further installed and is electrically coupled with the controller for adjusting and setting a time duration for each of various illumination modes, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to turn on the dimmable LED bulb to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit operates to increase the average electrical power transmitted to the dimmable LED bulb to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein a light intensity of the second level illumination is higher than the light intensity of the first level illumination, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to turn off the dimmable LED bulb;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during a performance of the first illumination mode, the low level illumination creates four advantages in performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein a third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff due to expiration of a timer while a person is still in a detection space and a simple interruption motion can bring the LED security light back to the high level illumination, wherein a fourth advantage is an occupancy declaration that a living space being occupied to discourage an intrusion or break in intention.

17. The lifestyle LED security light according to claim **16**, wherein the controller is an integrated circuit device programmable for generating the control signal.

18. The lifestyle LED security light according to claim **16**, wherein the controller is an application specific integrated circuit customized for generating the control signal.

19. The lifestyle LED security light according to claim **16**, wherein the dimmable LED bulb comprises at least a full wave rectifier and a DC LED module configured with a plurality of LEDs, wherein the full wave rectifier converts the AC power delivered by the phase controller into a DC power, wherein the plurality of LEDs of the DC LED module are designed to be a combination of in parallel and/or in series connections of N number LEDs or N sets of LEDs, where N is a positive integer, for matching with the DC power converted by the full-wave rectifier such that an average electric current passing through each LED of the DC LED module remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when the DC LED module is configured with N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the DC LED module is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

20. The lifestyle LED security light according to claim **19**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the DC LED module is thereby confined in a domain $N\times2.5$ volts$<V_N<N\times3.5$ volts.

21. The lifestyle LED security light according to claim **16**, wherein the dimmable LED bulb comprises at least an AC LED module containing two polarity reverse LED arrays connected in parallel, wherein each of the two polarity reverse LED arrays is configured with a plurality of LEDs, wherein the plurality of LEDs are designed to be a combination of in parallel and/or in series connections of N number LEDs or N sets of LEDs, where N is a positive integer, for matching with the AC power delivered by the phase controller such that an electric current passing through each LED of the two polarity reverse LED arrays remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when each of two polarity reverse LED arrays is configured with N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each of the two polarity reverse LED arrays is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

22. The lifestyle LED security light according to claim **21**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage

V_N imposed on each of two polarity reverse LED arrays is thereby confined in a domain N×2.5 volts<V_N<N×3.5 volts.

23. A lifestyle LED security light control device, comprising:

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the lifestyle LED security light control device is to be electrically connected to a dimmable LED bulb, wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the dimmable LED bulb, wherein the controller outputs control signals to control the switching circuitry for delivering different average electric powers from the power source to the dimmable LED bulb for generating different illuminations, wherein the controller controls the switching circuitry to deliver different average electric powers to the dimmable LED bulb such that the LED security light respectively performs at least two illumination modes with different light intensities according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power supply unit includes an AC/DC power converter to convert an AC power of an AC power source into a DC power for operating the LED security light, wherein the power source is the AC power source, wherein the switching circuitry includes a phase controller containing a bidirectional semiconductor switching device, wherein the bidirectional semiconductor switching device is electrically connected in series between the AC power source and the dimmable LED bulb, and wherein the controller incorporated with a zero-crossing point detection circuit outputs a time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power source to control the conduction rate of the phase controller for delivering different average AC power to the dimmable LED bulb for performing different illumination modes according to signals received from the light sensing control unit and the motion sensing unit; wherein in order to ensure a successful conduction of the dimmable LED bulb the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage at which the dimmable LED bulb starts to emit light in each positive and negative half cycle of the AC power;

wherein a time setting unit is further installed and is electrically coupled with the controller for adjusting and setting a time duration for each of the different illumination modes, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit operates to increase the average electric power transmitted to the dimmable LED bulb to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein a light intensity of said second illumination mode is higher than the light intensity of said first illumination mode, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to turn off the dimmable LED bulb;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during the performance of the first illumination mode, the low level illumination creates four advantages in performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein the third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff due to expiration of a timer while a person is still in a detection space, wherein a fourth advantage is an occupancy declaration that a living space being occupied to discourage an intrusion or break in intention.

24. The lifestyle LED security light control device according to claim **23**, wherein the controller is an integrated circuit device programmable for generating the control signal.

25. The lifestyle LED security light control device according claim **23**, wherein the controller is an application specific integrated circuit customized for generating the control signal.

26. The lifestyle LED security light control device according to claim **23**, wherein the dimmable LED bulb comprises at least a full wave rectifier, and a DC LED module configured with a plurality of LEDs, wherein the full wave rectifier converts the AC power delivered by the phase controller into a DC power, wherein the plurality of LEDs of the DC LED module are designed to be a combination of in parallel and/or in series connections of N number LEDs or N sets of LEDs, where N is a positive integer, for matching with the DC power converted by the full-wave rectifier such that an average electric current passing through each LED of the DC LED module remains at a safety level and a voltage V across each LED complies with an operating constraint of V_{th}<V<V_{max} featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when the DC LED module is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the DC LED module is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as N×V_{th}<V_N<N×V_{max}.

27. The lifestyle LED security light control device according to claim **26**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts<V_{th}<V<V_{max}<3.5 volts and the working voltage V_N imposed on the DC LED module is thereby confined in a domain N×2.5 volts<V_N<N×3.5 volts.

28. The lifestyle LED security light control device according to claim **23**, wherein the dimmable LED bulb comprises at least an AC LED module configured with two polarity reverse LED arrays connected in parallel, wherein each of the two polarity reverse LED arrays is designed to be a combination of in series and/or in parallel connections of N number LEDs or N sets of LEDs, where N is a positive integer, for matching with the AC power delivered by the phase controller such that an electric current passing through each LED remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when each of the two polarity reverse LED arrays is configured with N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each LED array is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N \times V_{th}<V_N<N \times V_{max}$.

29. The lifestyle LED security light control device according to claim **28**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on of the two polarity reverse LED arrays is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

30. A method of dimming an LED light bulb powered by an AC power, comprising:

using a phase controller electrically coupled between an AC power and the LED light bulb to control a transmission of an average electric power delivered to the LED light bulb;

using a zero crossing point detection circuit to identify a zero crossing point information in each AC half cycle;

using a controller incorporating with the zero-crossing point detection circuit to output a time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power to control a conduction rate of the phase controller for delivering an average electric power to the LED light bulb for generating an illumination, wherein in order to ensure a successful conduction of the LED light bulb the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage of the LED light bulb at which the LED light bulb starts emitting light; and

using an external control device to output an external control signal to the controller to accordingly output the time delay pulse to control the conduction rate of the phase controller;

wherein the phase controller contains a bidirectional semiconductor switching device, wherein the LED light bulb comprises at least a full wave rectifier, a driving circuitry and a DC LED module configured with a plurality of light emitting diodes electrically coupled with the full wave rectifier, wherein the full wave rectifier converts the AC power delivered by the phase controller into a DC power, wherein the driving circuitry further transforms the DC power delivered by the full wave rectifier into an adequate DC power level for driving the DC LED module for generating the illumination;

wherein the plurality of LEDs of the DC LED module are designed to be a combination of in parallel and/or in series connections such that when incorporated with the adequate DC power provided by the driving circuitry an average electric current passing through each LED of the DC LED module remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction.

31. A method of dimming an LED light bulb powered by an AC power, comprising:

using a phase controller electrically coupled between an AC power source and an LED light bulb to control a transmission of an average electric power delivered to the LED load;

using a zero crossing point detection circuit to identify a zero crossing point in each half cycle of the AC power;

using a controller incorporating with the zero-crossing point detection circuit to output a time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power to control a conduction rate of the phase controller for delivering an average electric power to drive the LED light bulb for generating an illumination, wherein in order to ensure a successful conduction of the phase controller the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage at which the LED load starts to emit light in each positive and negative half cycle of the AC power; and

using an external control device to output an external control signal to the controller to accordingly output the time delay pulse to control the conduction rate of the phase controller;

wherein the phase controller contains a bidirectional semiconductor switching device, wherein the LED light bulb further comprises at least a driving circuitry and an AC LED module configured with two polarity reverse LED arrays connected in parallel, wherein the driving circuitry transforms the AC power delivered by the phase controller into an adequate power levels for driving the AC LED module for generating the illuminations, wherein a first LED array conducts in a positive half cycle while a second LED array conducts in a negative half cycle;

wherein each of the two polarity reverse LED arrays is designed to be a combination of in series and/or in parallel connections such that when incorporated with the adequate DC power provided by the driving circuitry an electric current passing through each LED remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of each LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when each of the two polarity reverse LED arrays is configured with a plurality of N number LEDs or N

sets of LEDs electrically connected in series, a working voltage V_N across each of the two LED arrays is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N \times V_{th} < V_N < N \times V_{max}$.

32. A lifestyle LED security light control device, comprising:

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

a time setting unit;

wherein the lifestyle LED security light control device is to be electrically connected to a dimmable LED bulb;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the dimmable LED bulb, wherein the switching circuitry comprises at least a semiconductor switching device for controlling a transmission of an electric power delivered to the dimmable LED bulb, wherein the controller outputs a control signal to control a conduction rate of the switching circuitry for delivering at least one electric power from the power source to drive the dimmable LED bulb for generating at least one illumination according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power supply unit includes an AC/DC power converter to convert an AC power of an AC power source into a DC power for operating the lifestyle LED security light, wherein the power source is the AC power source, wherein the semiconductor switching device is a phase controller containing a bidirectional semiconductor switching device, wherein the control signal is a time delay pulse to control a conduction state of the bidirectional semiconductor switching device in each half cycle of the AC power, wherein the controller incorporating with a zero-crossing point detection circuit outputs the time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power to control a conduction rate of the phase controller for delivering at least one average electric power to drive the dimmable LED bulb for generating at least one illumination according to signals received from the light sensing control unit and the motion sensing unit, wherein in order to ensure a successful conduction of the dimmable LED bulb the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage of the lifestyle LED security light due to the dimmable LED bulb at which the dimmable LED bulb starts to emit light in each positive and negative half cycle of the AC power;

wherein the time setting unit is electrically coupled with the controller and is used for adjusting and setting a predetermined time duration for an illumination activated by the motion sensing unit;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to activate the motion sensing unit; wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to deliver an average electric power to the dimmable LED bulb to generate the illumination for the predetermined time duration preset by the time setting unit;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to switch off the dimmable LED bulb.

33. The lifestyle LED security light control device according to claim **32**, wherein the controller is an integrated circuit device programmable for generating the control signal.

34. The lifestyle LED security light control device according to claim **32**, wherein the controller is an application specific integrated circuit customized for generating the control signal.

35. The lifestyle LED security light control device according to claim **32**, wherein the dimmable LED bulb comprises at least a full wave rectifier, a driving circuitry and a DC LED module configured with a plurality of LEDs, wherein the plurality of LEDs of the DC LED module are designed to be a combination of in parallel and/or in series connections such that when incorporated with an adequate DC power from the driving circuitry an average electric current passing through each LED of the DC LED module remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th} < V < V_{max}$ featuring electrical characteristics of each LED, wherein V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when the DC LED module is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each of the two LED arrays is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N \times V_{th} < V_N < N \times V_{max}$.

36. The lifestyle LED security light control device according to claim **35**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on of the two polarity reverse LED arrays is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

37. The lifestyle LED security light control device according to claim **32**, wherein the dimmable LED bulb comprises at least a driving circuitry and an AC LED module configured with two polarity reverse LED arrays connected in parallel, wherein the driving circuitry transforms the AC power delivered by the phase controller into an adequate power level for driving the AC LED module for generating the illumination.

38. The lifestyle LED security light control device according to claim **37**, wherein each of the two polarity reverse LED arrays is designed to be a combination of in series and/or in parallel connections such that when incorporated with the adequate DC power from the driving circuitry an electric current passing through each LED of each LED array remains at a level and a voltage V across each LED complies with an operating constraint of $V_{th} < V < V_{max}$ fea-

turing electrical characteristics of each LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when each of the two polarity reverse LED arrays is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each LED array is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

39. A lifestyle LED lighting device, comprising:

a light-emitting unit comprising at least two LED lighting loads emitting lights with different color temperatures including at least a first LED lighting load emitting light with a low color temperature and a second LED lighting load emitting light with a high color temperature;

a light diffuser to cover the at least two LED lighting loads emitting lights with different color temperatures to create a diffused light with a mixed color temperature;

a loading and power control unit comprising at least a controller, a switching circuitry, and a power allocation circuitry;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

an external control unit, comprising at least a first external control device to manage the power allocation circuitry for selecting a desired mixed color temperature;

wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically coupled between a power source and the light-emitting unit, wherein the power allocation circuitry is installed between the switching circuitry and the at least two LED lighting loads respectively for managing a power allocation of an electric power controlled by the switching circuitry respectively delivered to the first LED lighting load and the second LED lighting load to determine a selection of the mixed color temperature, wherein the light-emitting unit is switched on or switched off by the light sensing control unit and controlled by the loading and power control unit, wherein the controller outputs a control signal to control the switching circuitry for delivering the electric power from the power source to drive the light-emitting unit for generating an illumination with a selected color temperature according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power source configured in the power supply unit outputs a DC power for operating the LED lighting device, wherein a time setting unit is further installed for adjusting and setting a predetermined time duration for the illumination activated by the motion sensing unit, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to activate the motion sensing unit, wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to deliver the electric power to the light-emitting unit to perform the illumination with the selected color temperature for the predetermined time duration set by the time setting unit, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to switch off the light-emitting unit.

40. The lifestyle LED lighting device according to claim **39**, wherein the LEDs of the first LED lighting load and the LEDs of the second LED lighting load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the DC power from the switching circuitry an electric current passing through each LED of the first LED lighting load and each LED of the second LED lighting load remains at a level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when each of the first LED lighting load and the second LED lighting load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each of the first LED lighting load and the second LED lighting load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

41. The lifestyle LED security light control device according to claim **40**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on of the two polarity reverse LED arrays is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

42. The lifestyle LED lighting device according to claim **39**, wherein the power allocation circuitry is configured to operate with at least two loading options respectively corresponding to two selections of different mixed color temperatures; wherein a first loading option includes only the first LED lighting load being connected to the switching circuitry to receive the electric power outputted by the switching circuitry for generating an illumination with the low color temperature, wherein a second loading option includes only the second LED lighting load being connected to the switching circuitry to receive the electric power outputted by the switching circuitry for generating an illumination with the high color temperature, wherein the power allocation circuitry is designed with a selection switch configured with at least two switching positions including a first switching position and a second switching position, wherein the selection switch is the first external control device operable by a user for respectively connecting the switching circuitry to operate the at least two loading options, wherein when the selection switch is connected to the first switching position for operating the first loading option, the switching circuitry is connected to the first LED lighting load to deliver the electric power to the first LED lighting load, wherein when the selection switch is connected to the second switching position for operating the second loading option, the switching circuitry is connected

to the second LED lighting load to deliver the electric power to the second LED lighting load.

43. The lifestyle LED lighting device according to claim **42**, wherein the selection switch is a slide switch configured with the at least two switching positions to respectively connect the switching circuitry to the first LED lighting load and the second LED lighting load.

44. The lifestyle LED lighting device according to claim **42**, wherein the selection switch is a rotary switch configured with the at least two switching positions to respectively connect the switching circuitry to the first LED lighting load and the second LED lighting load.

45. The lifestyle LED lighting device according to claim **39**, wherein the switching circuitry is an LED driver outputting a constant electric current, wherein the power allocation circuitry is configured to operate with at least three loading options respectively corresponding to three selections of different mixed color temperatures; wherein a first loading option includes only the first LED lighting load being connected to the switching circuitry to receive the electric power delivered by the switching circuitry for generating an illumination with the low color temperature, wherein a second loading option includes only the second LED lighting load being connected to the switching circuitry to receive the electric power delivered by the switching circuitry for generating an illumination with the high color temperature, wherein a third loading option includes both the first LED light load and the second LED lighting load being connected to the switching circuitry to receive the electric power delivered by the switching circuitry for generating an illumination with a medium color temperature between the low color temperature and the high color temperature, wherein the power allocation circuitry is designed with a selection switch configured with at least three switching positions respectively for operating the at least three loading options, wherein when the selection switch is connected to the first switching position for operating the first loading option, the electric power delivered by the switching circuitry is delivered to the first LED lighting load to generate the illumination with the low color temperature, wherein when the selection switch is connected to the second switching position for operating the second loading option, the electric power delivered by the switching circuitry is delivered to the second LED lighting load to generate the illumination with the high color temperature, wherein when the selection switch is connected to the third switching position for operating the third loading option, the switching circuitry is connected to both the first LED lighting load and the second LED lighting load and the electric power delivered by the switching circuitry is delivered to both the first LED lighting load and the second LED lighting load to generate the illumination with the medium color temperature.

46. The lifestyle LED lighting device according to claim **45**, wherein the selection switch is a slide switch configured with the at least three switching positions to respectively connect the switching circuitry to the first LED lighting load, the second LED lighting load and both the first LED lighting load and the second LED lighting load.

47. The lifestyle LED lighting device according to claim **45**, wherein the selection switch is a rotary switch configured with the at least three switching positions to respectively connect the switching circuitry to the first LED lighting load, the second LED lighting load and both the first LED lighting load and the second LED lighting load.

48. The lifestyle LED lighting device according to claim **39**, wherein the power allocation circuitry is electrically and respectively coupled to two LED lighting loads emitting lights with different color temperatures, wherein the power allocation circuitry comprises at least a first switching device electrically coupled between the switching circuitry and at least one of the two LED lighting loads emitting lights with different color temperatures, wherein the controller is further electrically coupled with the first external control device and the first switching device.

49. The lifestyle LED lighting device according to claim **48**, wherein the first switching device is a two-way relay electrically coupled to two LED lighting loads, wherein when the first external control device outputs a first external control signal to the controller, the controller responsively outputs a first control signal to manage the two-way relay to connect the switching circuitry to the first LED lighting load and the LED lighting device consequently operates to perform the illumination with the low color temperature whenever activated by the motion sensing unit, wherein when the first external control devices outputs a second external control signal to the controller, the controller responsively outputs a second control signal to manage the two-way relay to redirect the switching circuitry to connect to the second LED lighting load and the LED lighting device consequently operates to perform the illumination with the high color temperature whenever activated by the motion sensing unit.

50. The lifestyle LED lighting device according to claim **48**, wherein the first switching device is a first semiconductor switching device electrically coupled between the switching circuitry and the first LED lighting load, wherein a second switching device being a second semiconductor switching device is further installed and is electrically coupled between the switching circuitry and the second LED lighting load, wherein the second semiconductor switching device is also electrically coupled with the controller, wherein the power allocation circuitry includes the first semiconductor switching device and the second semiconductor switching device and is operated by a power allocation process designed to distribute and allocate the electric power delivered by the switching circuitry into a first electric power delivered to the first LED lighting load and a second electric power delivered to the second LED lighting load for adjusting and setting the mixed color temperature of the LED lighting device when activated by the motion sensing unit;

wherein for tuning the mixed color temperature to a lower color temperature, the controller upon receiving the at least one first external control signal operates to increase a conduction rate of the first semiconductor switching device to increase the first electric power delivered to the first LED lighting load and at the same time operates to decrease the conduction rate of the second semiconductor switching device to proportionally decrease the second electric power delivered to the second LED lighting load;

wherein for tuning the mixed color temperature to a higher color temperature, the controller upon receiving the at least one first external control signal operates to decrease the conduction rate of the first semiconductor switching device to decrease the first electric power delivered to the first LED lighting load and at the same time operates to increase the conduction rate of the second semiconductor switching device to proportionally increase the electric power delivered to the second LED lighting load.

51. The lifestyle LED lighting device according to claim **50**, wherein the controller is designed with a color temperature switching scheme, wherein paired combinations of the

first electric power delivered to the first LED lighting load and the second electric power delivered to the second LED lighting load for creating different mixed color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the at least one first external control signal generated by the first external control device for performing a selected mixed color temperature.

52. The lifestyle LED lighting device according to claim **51**, wherein the at least one first external control signal is a short power interruption signal generated by a main power switch, a push button or a touch sensor, wherein a power interruption detection circuit is electrically coupled with the controller, wherein when a power interruption signal is detected by the power interruption detection circuit and converted into a message sensing signal interpretable by the controller, the controller operates to alternately perform a color temperature performance in the color temperature switching scheme according to a prearranged sequence.

53. The lifestyle LED lighting device according to claim **52**, wherein when the main power switch is used for generating the short power interruption signal, the main power switch is turned off and turned back on within a predetermined time interval.

54. The lifestyle LED lighting device according to claim **52**, wherein when the push button or the touch sensor is used for generating the short power interruption signal, a signal detection circuitry is connected to the push button switch or the touch sensor, wherein when the push button switch or the touch sensor is operated for a short time interval a voltage signal with a time length equal to the short time interval is transmitted to the signal detection circuitry and the signal detection circuitry accordingly manages to transmit the short power interruption signal to the power interruption detection circuit for converting to the message sensing signal interpretable by the controller, the controller accordingly operates to alternately perform a color temperature performance in the color temperature switching scheme according to a prearranged sequence.

55. The lifestyle LED lighting device according to claim **51**, wherein the first external control device is a voltage divider operated by a user to output at least two voltage signals interpretable by the controller for executing the pick and play process for selecting and performing a corresponding color temperature performance in the color temperature switching scheme.

56. The lifestyle LED lighting device according to claim **55**, wherein the voltage divider is operated with a configuration of a slide switch or a rotary switch designed with a plurality of switching positions operable by a user for selecting and performing a corresponding color temperature performance from the color temperature switching scheme.

57. The lifestyle LED lighting device according to claim **51**, wherein the first external control device is a wireless signal receiver electrically coupled with the controller to receive a wireless external control signal, wherein the at least one first external control signal is at least one wireless external control signal convertible to at least one message sensing signal with a signal format interpretable by the controller for activating the pick and play process to select and perform a corresponding color temperature performance in the color temperature switching scheme.

58. The lifestyle LED lighting device according to claim **51**, wherein the at least one first external control signal is an infrared light reflected from an object entering and staying in a detection zone, wherein the first external control device is an active infrared ray sensor for detecting the infrared light reflected from the object and converting the infrared light reflected from the object into the at least one message sensing signal with a signal format interpretable by the controller for executing the pick and play process for selecting and performing a corresponding light color temperature performance from the color temperature switching scheme.

59. The lifestyle LED lighting device according to claim **51**, wherein the color temperature switching scheme comprises at least a high color temperature performance and a low color temperature performance, wherein for performing the high color temperature performance the electric power is delivered to the second LED lighting load, wherein for performing the low color temperature performance the electric power is delivered to the first LED lighting load.

60. The lifestyle LED lighting device according to claim **51**, wherein the color temperature switching scheme comprises at least a high color temperature performance, a low color temperature performance and a medium color temperature performance, wherein for performing the high color temperature performance the electric power is delivered to the second LED lighting load, wherein for performing the low color temperature performance the electric power is delivered to the first LED lighting load, wherein for performing the medium color temperature performance the electric power is distributed and respectively delivered to the first LED lighting load and the second LED lighting load.

61. The lifestyle LED security light according to claim **48**, wherein the at least one switching device is electrically connected between the switching circuitry and the second LED lighting load, wherein the controller is further installed to be electrically coupled with the first external control device and the first switching device, wherein the first external control device outputs at least one first external control signal to the controller, wherein when the controller receives the at least one first external control signal from the first external control device, the controller responsively outputs at least one first control signal to control a conduction state of the first switching device to manage the power allocation circuitry to respectively deliver the first electric power to the first LED lighting load and the second electric power to the second LED lighting load according to the power allocation algorithm for adjusting and setting the mixed light color temperature; wherein when the first switching device is cut off, the electric power is delivered to the first LED lighting load to generate the illumination with the low color temperature; wherein when the first switching device is conducted, the electric power is allocated between the first LED lighting load and the second LED lighting load to generate the illumination with a medium light color temperature.

62. The lifestyle LED security light according to claim **38**, wherein the switching circuitry is an LED driver outputting a constant electric current.

63. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the con-

troller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the LED load is switched on or switched off by the light sensing control unit and controlled by the loading and power control unit, wherein the switching circuitry comprises at least one semiconductor switching device, wherein the power source configured in the power supply unit outputs a DC power for operating the LED lighting device;

wherein the controller outputs control signals to control the at least one semiconductor switching device of the switching circuitry for delivering different average electric powers from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes for respective predetermined time durations activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein the time setting unit is electrically coupled with the controller and is used for adjusting and setting at least a time length of the predetermined time durations;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to activate the motion sensing unit and the light-emitting unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit to generate a high level illumination for a predetermined time duration;

wherein upon a maturity of the predetermined time duration, the loading and power control unit manages to turn off the light-emitting unit thru a delay shutoff process, wherein the delay shutoff process is designed with a two-stage approach; wherein for the first stage of the delay shut off process, the loading and power control unit manages to drop the illumination of the light-emitting unit to a noticeably lower level and continues the noticeably lower level illumination for a short time period, wherein upon a maturity of the short time period the loading and power control unit manage to turn off the light-emitting unit;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller;

wherein the LED load in conjunction with an adequate level of the DC power from the switching circuitry is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when the LED load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$;

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

64. The LED security light according to claim **63**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the LED load is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

65. The LED security light according to claim **63**, wherein during the delay shutoff off process if a new motion signal is further detected by the motion sensing unit indicating an occupant remaining in the detection area, the loading and power control unit manages resume the high level illumination and to restart a new cycle of the high level illumination for a new predetermined time duration;

wherein during the delay shutoff process if no further motion signal is received, indicating the detection area is unoccupied, the light-emitting unit is thereby successfully turned off.

66. The LED security light according to claim **65**, wherein the new predetermined time duration is equal to the predetermined time duration used prior to restarting the new cycle of the high level illumination.

67. The LED security light according to claim **65**, wherein the new predetermined time duration is programmed to be longer than the predetermined time duration used prior to restarting the new cycle of the high level illumination according to a programmed combination of increasing delay times.

68. The LED security light according to claim **63**, wherein the power supply unit is configured with an AC/DC power converter to convert an AC power into a least one DC power required for operating the LED security light.

69. The LED security light according to claim **63**, wherein the power supply unit comprises a battery module to output at least one DC power for operating the lifestyle LED security light.

70. The LED security light according to claim **69**, wherein the battery module is a rechargeable battery module.

71. The LED security light according to claim **70**, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

72. A lifestyle LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the LED load is switched on or switched off by the light sensing control unit and controlled by the loading and power control unit, wherein the switching circuitry comprises at least one semiconductor switching device, wherein the power source configured in the power supply unit outputs a DC power for operating the LED lighting device;

wherein the controller outputs control signals to control the at least one semiconductor switching device of the switching circuitry for delivering different average electric powers from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes for respective predetermined time durations activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein the time setting unit is electrically coupled with the controller and is used for adjusting and setting at least a time length of the predetermined time durations;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the light-emitting unit to generate a low level illumination;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to increase the electric power delivered to the light-emitting unit to generate a high level illumination for a predetermined time duration;

wherein upon a maturity of the predetermined time duration, the loading and power control unit manages to reduce the electric power delivered to the light emitting unit to resume the low level illumination; wherein if a new motion signal is further detected within a short time period since a resumption of the low level illumination indicating at least one occupant remaining in the detection area, the loading and power control unit manages to resume the high level illumination for a new predetermined time duration, wherein the new predetermined time duration is programmed to be longer than the predetermined time duration used prior to restarting the new cycle of the high level illumination according to a programmed combination of increasing delay times;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller;

wherein the LED load in conjunction with an adequate level of the DC power from the switching circuitry is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when the LED load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$;

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

73. The lifestyle LED security light according to claim **72**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the LED load is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

74. The lifestyle LED security light according to claim **72**, wherein the power supply unit is configured with an AC/DC power converter to convert an AC power into a least one DC power required for operating the LED security light.

75. The lifestyle LED security light according to claim **72**, wherein the power supply unit comprises a battery module to output at least one DC power for operating the lifestyle LED security light.

76. The lifestyle LED security light according to claim **75**, wherein the battery module is a rechargeable battery module.

77. The lifestyle LED security light according to claim **76**, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

* * * * *

EXHIBIT D

US009326362B2

(12) **United States Patent**
Chen

(10) **Patent No.:** **US 9,326,362 B2**
(45) **Date of Patent:** **Apr. 26, 2016**

(54) **TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR**

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(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/487,334**

(22) Filed: **Sep. 16, 2014**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

(51) **Int. Cl.**

H05B 37/02	(2006.01)
H05B 33/08	(2006.01)
G08B 15/00	(2006.01)
G08B 13/189	(2006.01)

(52) **U.S. Cl.**

CPC ***H05B 37/0281*** (2013.01); ***G08B 15/00*** (2013.01); ***H05B 33/0818*** (2013.01); ***H05B 33/0827*** (2013.01); ***H05B 33/0854*** (2013.01); ***H05B 33/0872*** (2013.01); ***H05B 37/0218*** (2013.01); ***H05B 37/0227*** (2013.01); *G08B 13/189* (2013.01); *Y02B 20/40* (2013.01); *Y02B 20/44* (2013.01); *Y02B 20/46* (2013.01)

(58) **Field of Classification Search**

USPC 315/149, 150, 291, 308, 360; 340/541, 340/565

See application file for complete search history.

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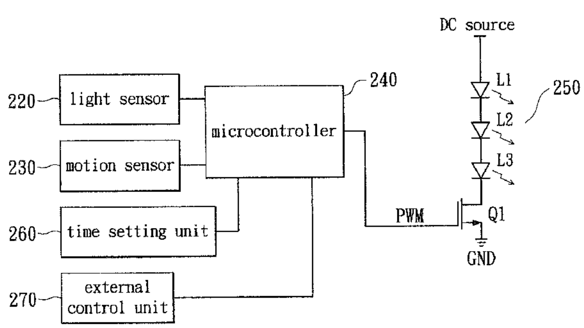
Primary Examiner — Thuy Vinh Tran

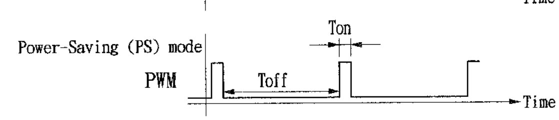
(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A two-level LED security light includes a power supply unit, a motion sensing unit, a time setting unit, a loading and power control unit, an external control unit, and a lighting-emitting unit. The LED security light is turned on at dusk for generating a first level illumination and turned off at dawn. When the motion sensor detects any intrusion, the LED security light is switched from the first level illumination to a second level illumination for a short duration time to scare away the intruder. After the short duration time, the LED security light returns to the first level illumination for saving energy. The light-emitting unit includes one or a plurality of LEDs. The time setting unit is for managing illumination timing. The external control unit is for setting illumination characteristics of the first level illumination or the second level illumination of the light-emitting unit.

26 Claims, 7 Drawing Sheets





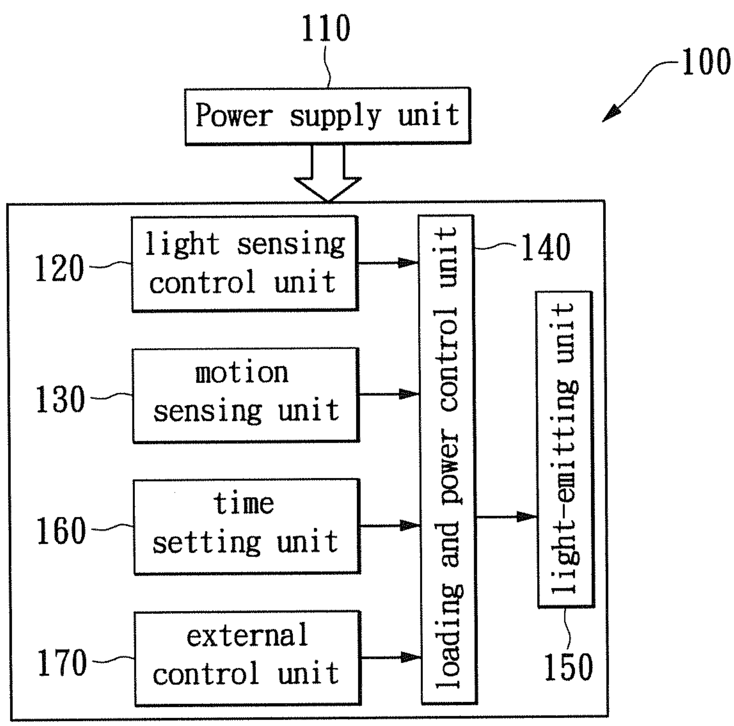
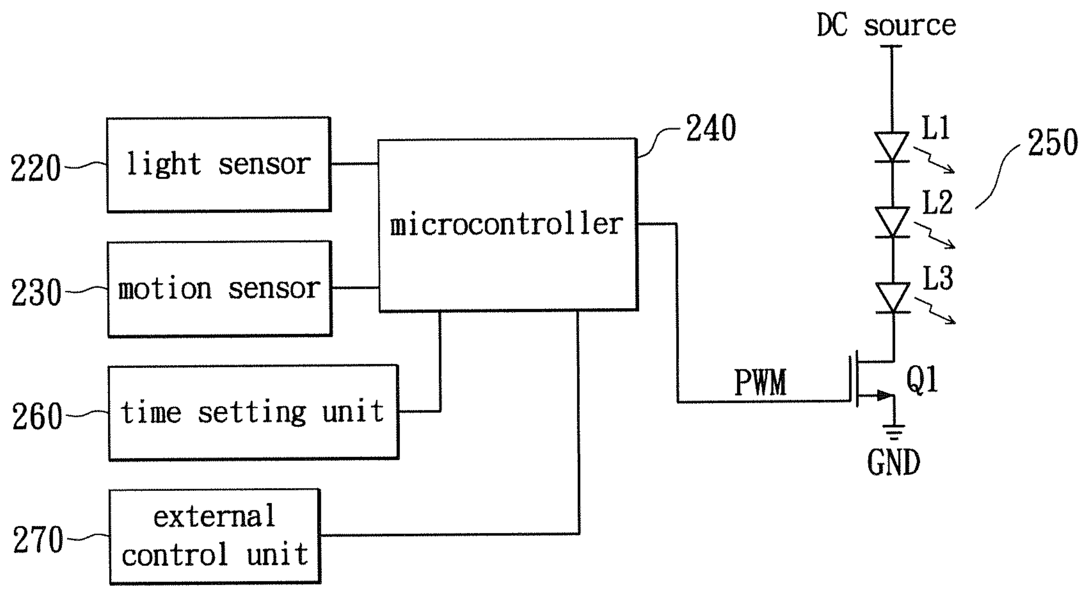

110
100
Power supply unit
120
light sensing control unit
140
130
motion sensing unit
160
time setting unit
170
external control unit
loading and power control unit
light-emitting unit
150

FIG. 1



DC source
240
L1
250
220
light sensor
microcontroller
L2
230
motion sensor
L3
260
time setting unit
PWM
Q1
GND
270
external control unit

FIG. 2A

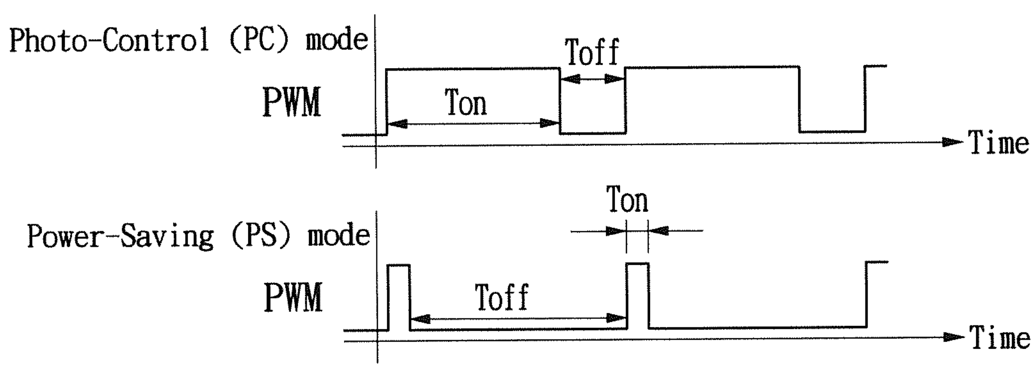


Photo-Control (PC) mode
Toff
PWM
Ton
Time
Ton
Power-Saving (PS) mode
PWM
Toff
Time

FIG. 2B

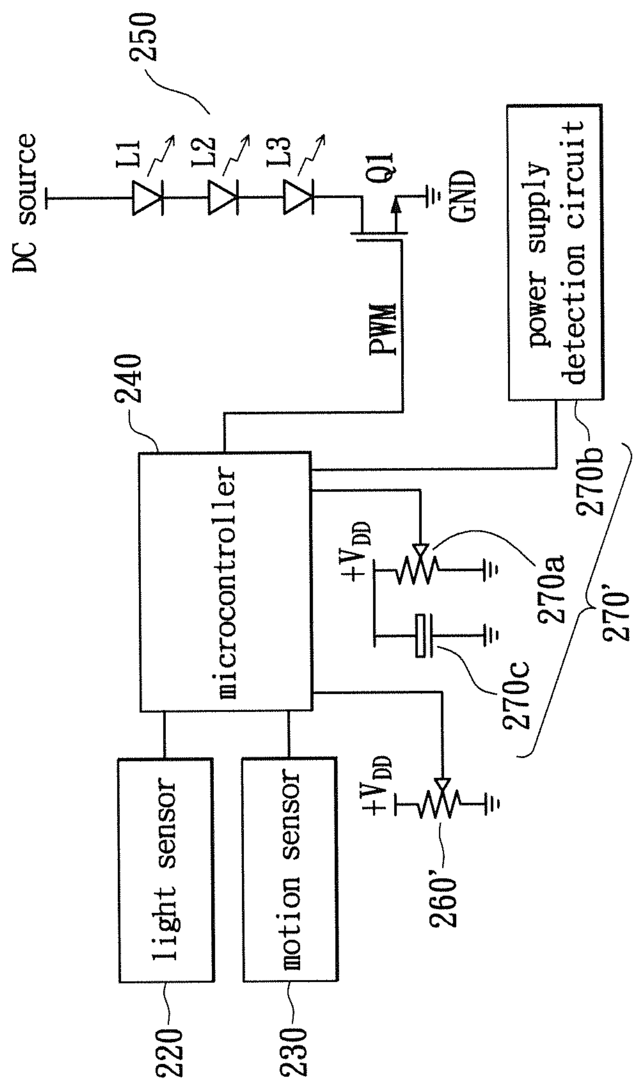

250
DC source
L1
L2
L3
Q1
GND
PWM
power supply detection circuit
240
microcontroller
$+V_{DD}$
270a
270b
270c
270'
$+V_{DD}$
260'
light sensor
motion sensor
220
230

FIG. 2C

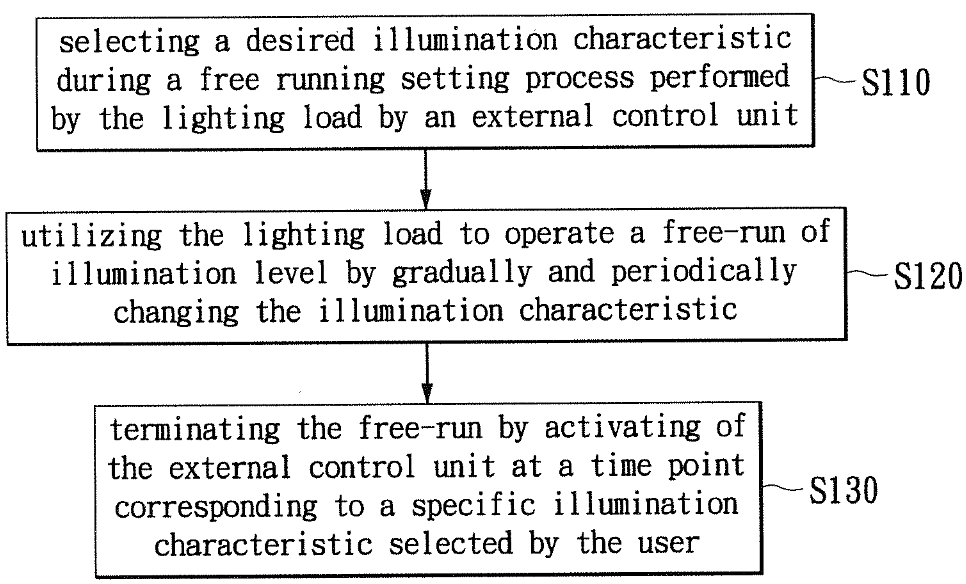

selecting a desired illumination characteristic during a free running setting process performed by the lighting load by an external control unit
S110
utilizing the lighting load to operate a free-run of illumination level by gradually and periodically changing the illumination characteristic
S120
terminating the free-run by activating of the external control unit at a time point corresponding to a specific illumination characteristic selected by the user
S130

FIG. 2D

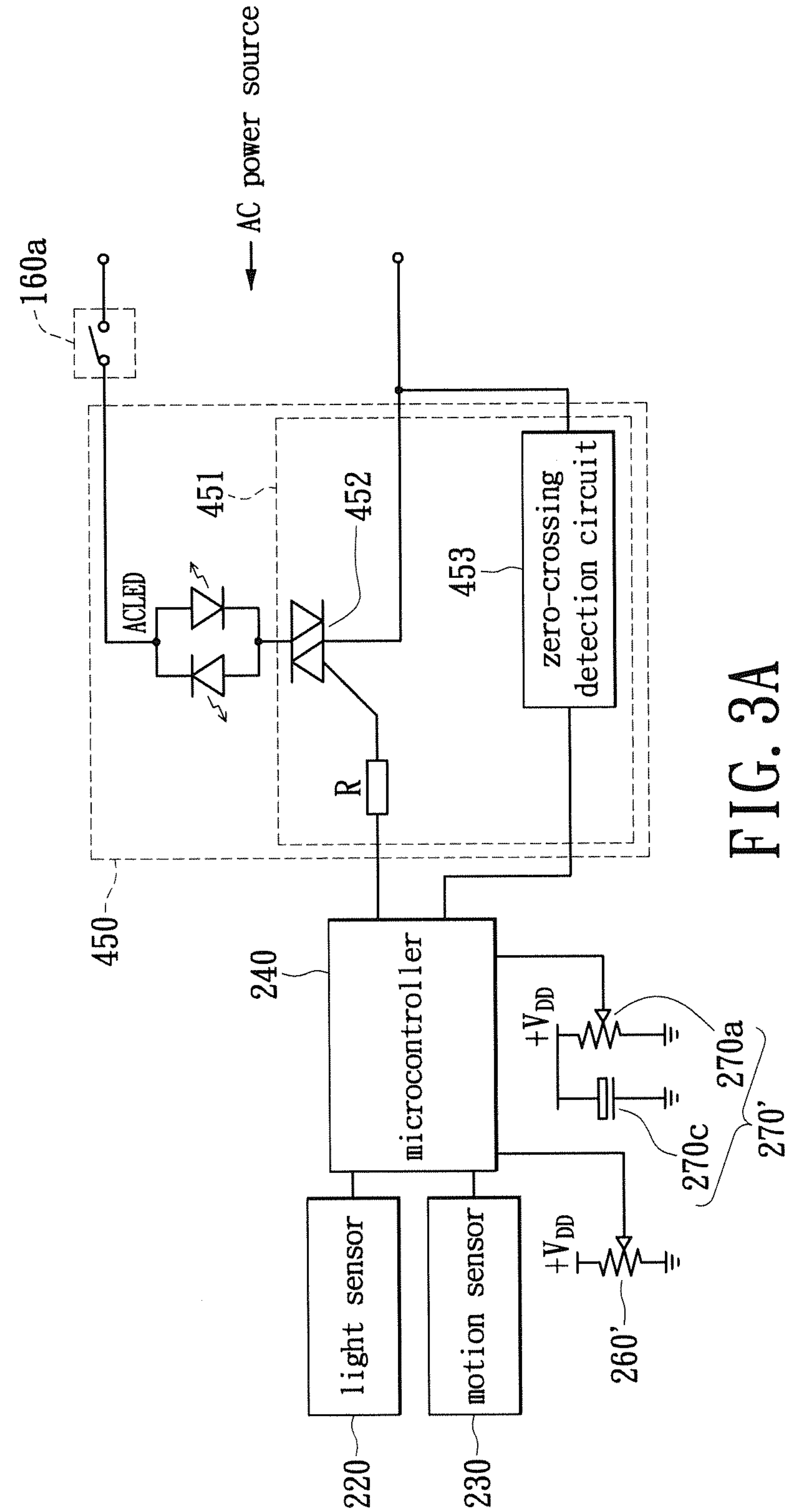

AC power source
160a
450
451
452
453
ACLED
R
zero-crossing
detection circuit
240
microcontroller
$+V_{DD}$
270a
270c
270'
$+V_{DD}$
260'
light sensor
motion sensor
220
230

FIG. 3A

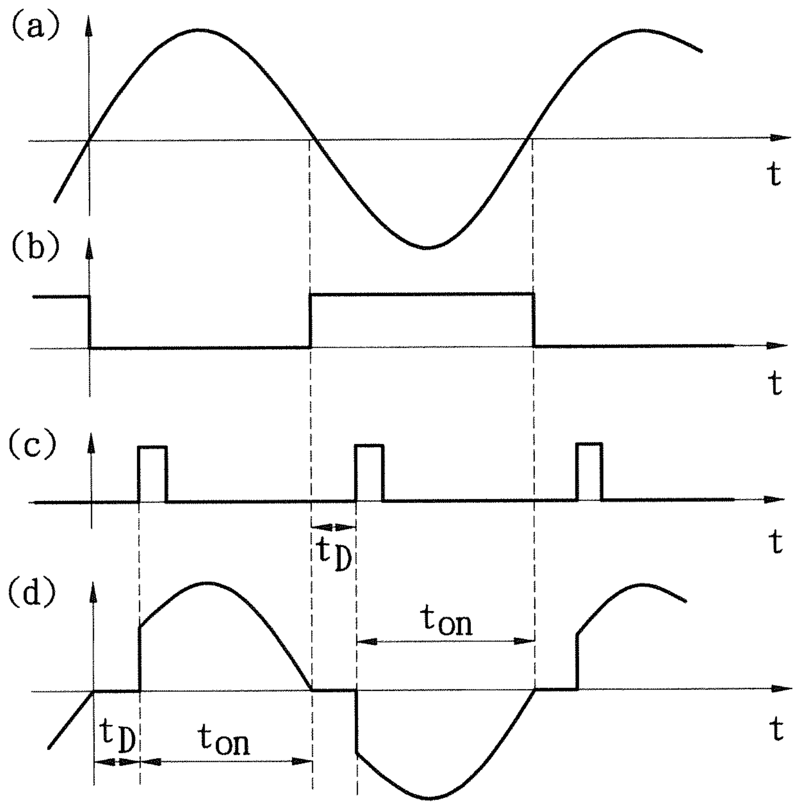


FIG. 3B

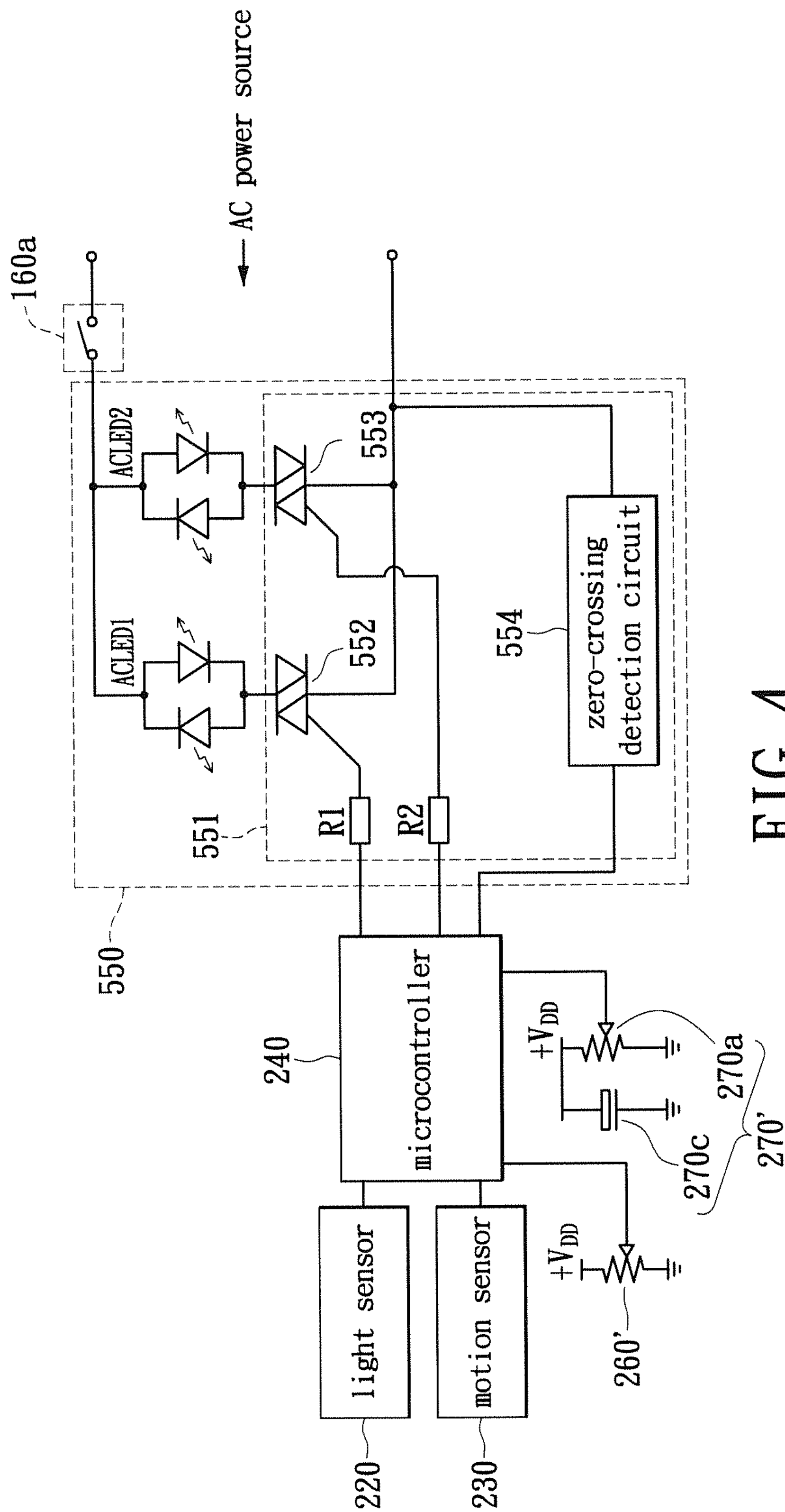

AC power source
160a
ACLED2
ACLED1
553
552
551
550
554
zero-crossing detection circuit
R1
R2
240
microcontroller
$+V_{DD}$
270a
270c
270'
$+V_{DD}$
260'
light sensor
motion sensor
220
230

FIG. 4

TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR

CROSS-REFERENCE TO RELATED APPLICATIONS

This Application is a continuation-in-part of Non-provisional application Ser. No. 13/222,090 filed on Aug. 31, 2011, which is now U.S. Pat. No. 8,866,392.

BACKGROUND

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photoresistors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to a second level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in a first level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light, comprising a light-emitting unit, a loading and power control unit, a light sensing control unit, a motion sensing unit, a power supply unit, and an external control unit coupled with the loading and power control unit. The light emitting unit comprises at least one LED. The loading and power control unit comprises a microcontroller electrically coupled with a semiconductor switching device, wherein the semiconductor switching device is electrically connected in series with the power supply unit and the light emitting unit, wherein the microcontroller with program codes outputs a pulse width modulation (PWM)

signal to a gate electrode of the semiconductor switching device to control the conduction period T_{on} and the cut-off period T_{off} of the semiconductor switching device for delivering different average electric currents from the power supply unit to drive the light emitting unit for generating different illuminations, wherein the microcontroller controls the semiconductor switching device respectively to have a first T_{on} and a second T_{on} of the conduction period such that the light-emitting unit respectively generates a first level and a second level illumination characterized by light intensity and/or color temperature according to the received signal outputted from the light sensing control unit and the motion sensing unit, wherein the external control unit is for setting illumination characteristics of at least one of the first level illumination and the second level illumination of the light-emitting unit.

Another exemplary embodiment of the present disclosure provides a two-level security light control device applicable to AC lighting sources, comprising a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a zero-crossing detection circuit, a phase controller, and an external control unit coupled with the loading and power control unit. The phase controller is in-series connected to an AC lighting source and an AC power source, wherein the loading and power control unit comprises a microcontroller for writing operation program to control a conduction period of the phase controller thereby to adjust the average power of the AC lighting source, wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the AC lighting source is turned on by the loading and power control unit thereby to generate a first level illumination and when the ambient light detected by the light sensing control unit is higher than the predetermined value, the AC lighting source is turned off by the loading and power control unit; when an intrusion is detected by the motion sensing unit, the loading and power control unit changes the average power of the AC lighting source and a second level illumination is generated for a predetermined duration, wherein the first level and the second level illumination are characterized by specific light intensity and/or color temperature, wherein the external control unit is for setting illumination characteristics of at least one of the first level illumination and the second level illumination of the light-emitting unit.

Another one exemplary embodiment of the present disclosure provides a two-level security light control device applicable to AC lighting sources, comprising a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a zero-crossing detection circuit, a plurality of phase controllers, and an external control unit coupled with the loading and power control unit. The plurality of phase controllers are respectively series-connected to a plurality of alternating current (AC) lighting sources, wherein the pairs of phase controller-AC lighting source are parallel-connected to an AC power source, wherein the loading and power control unit comprises a microcontroller for writing operation program to respectively control conduction periods of the phase controllers thereby to respectively adjust the average powers of the AC lighting sources, wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the AC lighting sources are turned on by the loading and power control unit to generate a first level illumination for a predetermined duration and when the ambient light detected by the light sensing control unit is higher than the predetermined value, the AC lighting sources are turned off, wherein when an intrusion is detected by the motion sensing unit, the loading and power control unit

changes the average power of the AC lighting sources to generate a second level illumination for a predetermined duration, wherein the first level and the second level illumination are characterized by specific light intensity and color temperature, wherein the external control unit is for setting the illumination characteristics of at least one of the first level illumination and the second level illumination of the AC lighting sources.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the present disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. The PC mode may generate a second level (high level, for example) illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a first level (low level, for example) illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediate switch to the second level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the first level illumination for saving energy. Further, the illumination characteristics of at least one of the first level illumination and the second level illumination of the light-emitting unit can be set by the user by means of an external control unit.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**C illustrates in some detail a schematic diagram of a two-level LED security light of FIG. **2**A.

FIG. **2**D illustrates a flow chart of a free running setting method in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a timing waveform of two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4** illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. A two-level LED security light (herein as the lighting apparatus) **100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, a light-emitting unit **150**, a time setting unit **160** and an external control unit **170**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The external control unit **170** is coupled with the loading and power control unit **140**, wherein the external control unit **170** can be manipulated by the user for adjusting illumination characteristics of at least one of a first level illumination and a second level illumination of the light-emitting unit **150**. The first level and the second level illumination are characterized by light intensity and/or color temperature. For example, the first level illumination and the second level illumination may be a low level illumination (or no illumination) and a high level illumination respectively, but the present disclosure is not so restricted. In other embodiment, the first level illumination may be a first color temperature level illumination, and the second level illumination may be a second color temperature level illumination. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs and switching components. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that the ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flows through the light-emitting unit

150, to generate a high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically reduce the electric current that flows through the light-emitting unit **150** thus to have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to FIG. **2**A in view of FIG. **1**, FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240**; the time setting unit **260** is the time setting unit **160**; and the external control unit **270** is the external control unit **170**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein an artisan of ordinary skill in the art will appreciate how to replace the transistor Q**1** by other type of the semiconductor switching device. The DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field effect transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a pulse width modulation (PWM) signal to the gate of transistor Q**1** to control the average electric current. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto. The external control unit **270** may be a push button, a touch panel or an infrared sensor for inputting voltage signal to adjust illumination characteristics of at least one of the first level illumination and the second level illumination of the light-emitting unit. Further, in another embodiment, the external control unit **270** may be a push button, a touch panel, an infrared sensor or a remote control device coupled or wirelessly linked to a pin of the microcontroller of the loading and power control unit; wherein, when the push button, the touch panel, the infrared sensor or the remote control device is activated, a voltage signal is generated to trigger the microcontroller **240** for the manual setting and the free-running setting (which would be explained thereafter) of the illumination characteristics. The external control unit **270** may be electrically coupled to the microcontroller **240** (that is the loading and power control unit **140**), such as utilizing electrically connection through conducting wire. In other embodiment, the external control unit **270** may be a remote control device, thus the external control unit **270** is wirelessly linked to the microcontroller **240** by using wireless techniques.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow the user to configure on software base a virtual timer embedded in the microcontroller **240** for executing a subroutine for a predetermined duration to perform the first level or the second level illumination respectively in the PC mode or in the PS mode. Further, if the microcontroller **240** is coupled to a clock device, the time setting unit **260** may allow the user to set a clock time point instead of a predetermined duration for switching from the PC mode to the PS mode. However, the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{on} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

Please refer to FIG. **2**A to further elucidate illumination level adjustment or setting. In order to adjust the illumination level of the light-emitting unit **250**, two exemplary control methods are applied by utilizing the external control unit **270**. Specifically, the first exemplary method is a manual adjustment applicable when the loading and power control unit **240** executes the Power-Saving (PS) mode for generating a first level illumination. The first level illumination is preferred an illumination of low light intensity and/or low color temperature. Refer to FIG. **2**A again, the microcontroller **240** may scan with its program codes a pin connected with the external control unit **270** and may detect control signal generated from the external control unit **270**. The external control unit **270** may be preferable a push button. When the push button is pressed down by a user to ground the connecting pin of the microcontroller **270**, a zero voltage is generated for a time duration until the push button is released, such that a control signal with a zero voltage of a time duration is generated manually by the user. The microcontroller **240** with program codes recognizes this control signal and by executing a subroutine generates a PWM signal with a conduction time period T_{on} periodically varying within a preset range of 0 to 50% duty (T_{on} is equal to T_{off}) for a time length controlled by the external control unit **270**, such that the LEDs **250** generate illumination with light intensity level gradually and periodically increasing from zero to 50% of the maximum light intensity and then decreasing from 50% to zero to complete a repetitive cycle. The time length of such periodical illumination variation is equal to the time duration of zero voltage generated by pushing down the push button **270**. Only when the push button **270** is released by the user, the periodical illumination variation is ended at a illumination level related to a specific T_{on} value determined by the user; then the microcontroller **240** jumps out of the subroutine of periodical illumination variation and stores thereafter the corresponding T_{on} value of the PWM signal in its memory to update a data base for generating a new first level illumination in the PS mode. In brief, by pressing down and releasing the push button **270** connected with a pin of the microcontroller **240**, the illumination level of the light-emitting unit **250** can be thus set manually by the user when the loading and power

control unit **240** executes the PS mode. However, the present disclosure is not limited thereto.

The second exemplary method is a free-running setting by program codes of microcontroller in conjunction with the external control unit. Refer to FIG. **2**A. When the lighting apparatus is turned on by the light sensor **220**, the microcontroller **240** starts its program codes by executing a subroutine in which PWM signal is generated with the conduction time period T_{on} periodically varying within a preset range of 0 to 50% duty for a fixed time period, such that the LEDs **250** generate illumination with light intensity level gradually and periodically increasing from zero to 50% of the maximum light intensity and then decreasing from 50% to zero light intensity to complete a variation cycle. This periodical variation of the low illumination level can last freely for two or three cycles within the fixed time period which is preferable to be one minute. However, it is not to limit the present invention in this manner. Within the one-minute fixed time period, for instance, the periodical illumination variation may be ended by activating the external control unit **270**. The external control unit **270** may be preferable a push button. When the push button is pressed down instantly by a user to ground the connecting pin of the microcontroller **270**, a zero voltage is generated to trigger the microcontroller **240** wherein the microcontroller **240** jumps out of the subroutine to terminate the free-running illumination variation and stores the T_{on} value of PWM signal corresponding to the time point when the external control unit **270** being activated. The stored T_{on} value is used to update a data base for generating the first level illumination in the PS mode. The free-run of periodical illumination variation may automatically end when the one-minute fixed time period expires with the external control unit **270** not being operated by the user; in this case, the microcontroller **240** jumps out of the subroutine of free-run and acquires from its memory a preset or earlier T_{on} value of PWM signal for generating the first level illumination in the PS mode until the lighting apparatus is turned off.

In brief, in a preferred embodiment of the present disclosure, a two-level LED security light may include a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit, a time setting unit and an external control unit. The external control unit is provided for adjusting or setting illumination level of LED light. The loading and power control unit is implemented by a microcontroller with program codes to operate the two-level LED security light. The microcontroller turns off the light-emitting unit during the day and activates a Power-Saving (PS) mode at night by turning on the light-emitting unit to generate a first level illumination, and upon human motion detection by switching the light-emitting unit to generate a second level illumination for a short time duration. The illumination characteristics of first level illumination can be changed by activating the external control unit according to the user's demand. When the lighting apparatus is turned on, the microcontroller starts its program codes by firstly executing a subroutine with free-run for a fixed time length, such that the user can follow the gradual and periodical illumination variation to select an illumination level by operating the external control unit; thereafter, the microcontroller jumps out of the subroutine of free-run and executes the program codes of PS mode for generating the first level illumination with the selected level characteristics until the lighting apparatus is turned off. If within the fixed time length of free-run the external control unit is not activated, the microcontroller jumps out of the subroutine of free-run automatically and, with a data base of a preset or earlier level characteristics, executes program codes of PS mode for generating the first level illumination until the lighting apparatus is turned off. The level characteristics can also be further adjusted manually by the user when loading and power control unit executes the PS mode. The external control unit may be preferable a push button. When in PS mode the light-emitting unit generates a first level illumination, the user can press the push button for a while to observe the gradual and periodical changing of level characteristic, and then decide at a time point to release the push button to select a desired illumination level, such that to complete manual adjustment.

Please refer to FIG. **2**C in view of FIG. **2**A and FIG. **2**B. Two preferred constructions respectively for the time setting unit **260'** and the external control unit **270'** are shown in FIG. **2**C. The time setting unit **260'** may be a voltage divider with variable resistor for setting predetermined time durations for the first level and the second level illumination. The external control unit **270'** may include a voltage divider **270*a*** which may comprise a variable resistor provided with a rotating knob to facilitate operation. For illumination level setting, the microcontroller operates with program codes preferably in conjunction with the voltage divider **270*a*** and further with a power supply detection circuit **270*b***, an energy storage capacitor **270*c*** and a power switch (not shown in FIG. **2**C) for respectively manual and free-running setting of at least one of a first level illumination and a second level illumination of the two-level LED security light; details of adjusting illumination level with the external control unit **270'** and other extra devices will be described later.

In order to adjust the illumination level of the light-emitting unit **250**, two exemplary control methods are applied by utilizing the external control unit **270*a*** and the software technique incorporating with extra devices **270*b*-270*c***. Specifically, the first exemplary method is a manual adjustment applicable in the Power-Saving (PS) mode for generating a first level illumination. Refer to FIG. **2**C again, the microcontroller **240** may scan with its program codes the voltage on a pin connected with the voltage divider **270*a*** and may detect a voltage, in which the voltage across of the variable resistor (voltage divider **270*a***) may be varied manually when a user rotates the knob attached on the variable resistor (voltage divider **270*a***). The microcontroller **240** with program codes generates in response a PWM signal with a conduction time period T_{on} proportional to a voltage received from the variable resistor (voltage divider **270*a***). The light-emitting unit **250** illuminates accordingly with light intensity level characterized by the conduction time period T_{on} controlled by the voltage of the variable resistor (voltage divider **270*a***). With the external control unit **270'**, the first illumination level of the light-emitting unit **250** can be thus set manually by tuning the variable resistor (voltage divider **270*a***) when the loading and power control unit **240** executes the PS mode.

The second exemplary method is a free-running adjustment based on program codes of microcontroller in conjunction with a power supply detection circuit and an energy-stored capacitor. Refer to FIG. **2**C, when the lighting apparatus is turned on, the microcontroller **240** starts its program codes firstly by executing a subroutine of free-run in which PWM signal is generated with the conduction time period T_{on} periodically varying within a preset range of 0 to 50% duty for a fixed time period, such that the LEDs **250** generate illumination with light intensity level gradually and periodically increasing from zero to 50% of the maximum light intensity and then decreasing from 50% to zero to complete a variation cycle. This periodical variation of the low illumination level can last freely for two or three cycles within the fixed time period which is preferable to be one minute. However, it is not to limit the present invention in this manner.

Within the one-minute fixed time period, for instance, the free-run of periodical illumination variation may be overridden by the user by turning off a power switch momentarily (for 1-2 seconds) and then switching it back on. At the moment when the power switch is turned off and then switched back on, the microcontroller **240** detects this OFF-ON event through a power supply detection circuit **270***b* and leaves the subroutine to terminate free-run, and simultaneously stores the T_{on} value of PWM signal related to the time point of the OFF-ON event to update a data base for generating the first level illumination in the PS mode. In general, the user can follow the gradual and periodical free-run of the low level lighting variation and select a favorable light intensity level by promptly turning the power switch off and again on (short power interruption). After overriding by power interruption, the microcontroller **240** jumps out of the subroutine of free-run and continues its program codes to execute the PS mode in which the illumination level is determined by the user. The free-run of periodical lighting variation may end automatically when the fixed time period expires with power interruption not being detected; the microcontroller **240** jumps out of the subroutine of free-run and acquires from its memory a preset or earlier T_{on} value of PWM signal for generating the first level illumination in the PS mode. Refer to FIG. **2**C again, an energy storage capacitor **270***c* is connected between the high end and the ground of the working voltage V_{DD}. This capacitor **270***c* is for holding the voltage V_{DD} to keep the circuits **240**, **270***b* still working when electric power is interrupted for 1-2 seconds. Therefore, when overriding free-run by short power interruption, an instant zero voltage is detected by the power supply detection circuit **270***b* and recognized by the microcontroller **240** to perform function for selecting and setting a desired illumination level.

In another embodiment, refer to FIG. **1** again, when an ambient light detected by the light sensing control unit **120** is lower than a predetermined value, the light-emitting unit **150** may be turned on thereby by the loading and power control unit **140** to generate an adjustable level illumination for a first predetermined duration and then turned off or switched to a low level illumination, when an intrusion is detected by the motion sensing unit **130**, the light-emitting unit **150** is turned on by the loading and power control unit **140** to generate a high level illumination for a second predetermined duration and then turned off or switched to a low level illumination until the next intrusion detection; when an ambient light detected by the light sensing control unit **120** is higher than the predetermined value, the light-emitting unit **150** is turned off by the loading and power control unit. The time setting unit **160** is used to set the first and the second predetermined duration respectively for the adjustable level illumination and the high level illumination. The external control unit **170** is used in two setting modes for setting illumination characteristics of the adjustable level illumination; wherein the first setting mode is a manual setting, in which the illumination level of the light-emitting unit is set in a preset range by activating the external control unit; **170** wherein the second setting mode is a free-running setting, in which the light-emitting unit performs a free-run of the adjustable level illumination with light intensity gradually and periodically increasing and then decreasing in a preset range to complete a cycle, wherein the free-run may be terminated by activation of the external control unit **170** at a time point corresponding to a specific light intensity level, such that the light-emitting unit performs the adjustable level illumination constantly with the specific light intensity level being set thereof.

In still another embodiment, a lighting management device is provided. Refer to FIG. **1** again, the lighting management device applicable to a lighting load such as the light-emitting unit **150**. The lighting management device comprises the loading and power control unit **140**, the power supply unit **110** and the external control unit **170** coupled with the loading and power control unit. The loading and power control unit **140** comprises a microcontroller (such as the microcontroller **240** shown in FIG. **2**A) electrically coupled with a semiconductor switching device (such as the transistor Q**1** shown in FIG. **2**A). The external control unit **170** may be a push button, a touch panel, an infrared sensor or a remote control device coupled or wirelessly linked to a pin of the microcontroller. The semiconductor switching device is electrically connected in series with the power supply unit and the lighting load, such as the transistor Q**1** is electrically connected in series with the DC source and the light-emitting unit **250**, wherein the microcontroller with written program code controls the conduction rate of the semiconductor switching device, wherein the external control unit **170** enables a user to select a desired illumination characteristic during a free running setting process performed by the lighting load, wherein the lighting load operates a free-run of illumination level by gradually and periodically changing the illumination characteristic, wherein the free-run may be terminated by activation of the external control unit **170** at a time point corresponding to a specific illumination characteristic selected by the user, wherein the microcontroller accordingly interprets the conduction rate of the semiconductor switching device at the time point when the external control unit **170** is activated and the free running is terminated to be the illumination characteristic set for illumination performance, the illumination characteristic is then memorized by the microcontroller for repetitive performance. Further, in one embodiment, the free run setting is terminated and the illumination characteristic of the lighting load is set by turning off a power switch instantly and turning it back on at the time point the lighting load performs a desired lighting characteristic selected by the user.

According to the previous embodiment, a free running setting method with activation of external control unit or through power switch interruption is provided. Refer to FIG. **2**D, the method comprises step S**110**: selecting a desired illumination characteristic during a free running setting process performed by the lighting load by an the external control unit; S**120**: utilizing the lighting load to operate a free-run of illumination level by gradually and periodically changing the illumination characteristic; and S**130**: terminating the free-run by activating of the external control unit or through power switch interruption at a time point corresponding to a specific illumination characteristic selected by the user, wherein the microcontroller accordingly interprets the conduction rate of the semiconductor switching device at the time point when the external control unit is activated or a power switch interruption is detected and the free running is terminated to be the illumination characteristic set for illumination performance, the illumination characteristic is then memorized by the microcontroller for repetitive performance.

In summary, in a preferred embodiment of the present disclosure, a two-level LED security light may employ an external control unit coupled to a loading and power control unit for adjusting or setting the illumination level of the LED light. The external control unit may be a push button, a voltage divider, a touch panel, an infrared sensor or other devices for generating control signals having different attributes depending on the category of the external control unit. For instance, a push button generates a binary signal having a zero voltage lasting for a time length equal to the time duration while the push button being pushed down; quite different, a voltage divider generates a DC voltage tuned by rotating a

rotary knob attached to the voltage divider. The loading and power control unit may be implemented by a microcontroller with program codes designed respectively accommodating to different control signals of different attributes for generating PWM signal with T_{on} value variable according to the control signal attribute, such as to carry out illumination level adjustment or setting. The illumination level characteristics including light intensity and color temperature can be thus set by operating the external control unit.

Second Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include a phase controller and one or more parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the first level and the second level illuminations. Refer to FIG. **3**A and FIG. **4** in conjunction with FIG. **1**, this embodiment provides a two-level security light control device applicable to AC lighting sources, comprising the power supply unit **110**, the light sensing control unit **120** (that is the light sensor **220**), the motion sensing unit **130** (that is the motion sensor **230**), the loading and power control unit **140** (that is the microcontroller **240**), a zero-crossing detection circuit **453**, a plurality of phase controllers (one phase controller **452** shown in FIG. **3**A and one phase controllers **551** shown in FIG. **4** are exemplary illustrated), the time setting unit **160** (that is the variable **260'**) and the external control unit **270'** coupled with the loading and power control unit **240**.

Refer to FIG. **3**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The operation of the external control **270'** can be referred to FIG. **2**C and the related description of manual and free-running setting of illumination level, and the earlier description thus the redundant information is not repeated. It is worth mentioning that the power supply detection circuit **270***b* is implemented by the zero-crossing detection circuit **453**, and the power switch mentioned in the previous embodiment can be implemented by the power switch **160***a* electrically coupled to the AC power source and the zero-crossing detection circuit **453**. For a two-level LED security light setting up at the ceiling or a high site far from the user, the free-run setting of the illumination level through instant power interruption by utilizing the power switch **160***a* is very convenient for the user, in which no any added switching device is needed. The main difference between FIG. **3**A and FIG. **2**C is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** includes a phase controller **451**, for ease of explanation, but the present disclosure is not so restricted. The phase controller **451** is in-series connected to the AC lighting source (ACLED) and the AC power source, wherein the microcontroller **240** is for writing operation program to control a conduction period of the phase controller **451** thereby to adjust the average power of the AC lighting source (ACLED). In another embodiment, a plurality of phase controller **451** can be also controlled by the microcontroller **240**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger the triac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<\frac{1}{2}{}_f-t_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(\frac{1}{2}\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t(rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (½f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D<6.1 ms.

Refer to FIG. **3**B, which illustrates a timing waveform of the two-level LED security light in accordance to the second exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **3**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **3**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square

waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **3**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **3**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **3**A and FIG. **3**B concurrently for setting ACLED illumination level. In manual setting, the microcontroller **240** with program codes controls the conduction time period t_{on} the ACLED to be in a preset range $0<t_{on}<\frac{1}{4}{}_{f}-t_0$; wherein by tuning the variable resistor (voltage divider **270***a*) the light intensity level of the ACLED can be adjusted between zero and 50% of the maximum light intensity. In the free-run setting of illumination level, the microcontroller **240** with program codes controls the conduction time period t_{on} of the ACLED to periodically change in a preset range $0<t_{on}<\frac{1}{4}f-t_0$, such that the ACLED generates illumination gradually and periodically increasing from zero to 50% and then decreasing from 50% to zero of the maximum light intensity. When following the free-run of lighting variation, the illumination level can be set through power interruption momentarily by utilizing the power switch **160***a*.

Refer to FIG. **4**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The operation of the external control **270'** can be referred to FIG. **2**C and the related description of manual and free-running setting of illumination level, and the earlier description thus the redundant information is not repeated. It is worth mentioning that the power supply detection circuit **270***b* is implemented by the zero-crossing detection circuit **554**, and the power switch mentioned in the previous embodiment can be implemented by the power switch **160***a* electrically coupled to the AC power source and the zero-crossing detection circuit **554**. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**, and a phase controller **551**. The phase controller **551** can be treated as two phase controllers **451** (shown in FIG. **3**A) which are parallel-connected. In still another embodiment, a plurality of phase controllers (**451** or **551**) are respectively series-connected to a plurality of alternating current (AC) lighting sources (ACLED), wherein the pairs of phase controller-AC lighting source are parallel-connected to the AC power source. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **4** is different from the light-emitting unit **450** of FIG. **3**A in that the light-emitting unit **550** has more than one ACLEDs and more than one bi-directional switching devices. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **4**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the second level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the first level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and the ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the second level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the first level or the second level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described two exemplary embodiments. This lighting apparatus may automatically generate first level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the first level illumination to the second level illumination, to provide the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder. Further, the illumination characteristic of at least one of the first level illumination and the second level illumination of the light-emitting unit can be set through two setting modes, namely, manual and free-running setting, such that the illumination characteristic is set to fulfill user's demand by activating an external control unit.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A two-level LED security light, comprising:

a light-emitting unit;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

an external control unit, coupled with the loading and power control unit;

wherein the light-emitting unit comprises at least one LED; wherein the loading and power control unit comprises a microcontroller electrically coupled with a semiconductor switching device, wherein the semiconductor switching device is electrically connected in series with the power supply unit and the light emitting unit, wherein the microcontroller with program codes outputs a pulse width modulation (PWM) signal to a gate electrode of the semiconductor switching device to control a conduction period (T_{on}) and a cut-off period (T_{off}) of the semiconductor switching device for delivering different average electric currents from the power supply unit to drive the light-emitting unit for generating different illuminations, wherein the microcontroller

controls the semiconductor switching device respectively to have a short conduction period (T_{on}) and a long conduction period (T_{on}) such that the light-emitting unit respectively generates a first level and a second level illumination characterized by light intensity and/or color temperature according to the signals received from the light sensing control unit and the motion sensing unit;

wherein the external control unit is used in at least one of two setting modes respectively for setting illumination characteristics of one of the first level and the second level illumination; wherein the first setting mode is a manual setting incorporating with the external control unit when the light-emitting unit generates one of the first level and the second level illumination, in which the illumination characteristic of the light-emitting unit is changed directly by operating the external control unit; wherein the second setting mode is a free-running setting, in which the light-emitting unit performs a free-run of one of the first level and the second level illumination by gradually and periodically changing illumination characteristics, wherein the free-run is terminated by operating the external control unit at a time point corresponding to a specific illumination characteristic, such that, following the free-running illumination variation, the illumination characteristics of one of the first level and the second level illumination is set by operating the external control unit at the time point when the light-emitting unit performs the specific illumination characteristic; wherein the light-emitting unit performs one of the first level and the second level illumination characterized by the specific illumination characteristic being set thereof.

2. The two-level LED security light according to claim **1**, wherein the external control unit is a push button, a touch panel, an infrared sensor or a wireless remote control device coupled to a pin of the microcontroller of the loading and power control unit; wherein, when the push button, the touch panel, the infrared sensor or the wireless remote control device is operated, a voltage signal is thereby generated to trigger the microcontroller for the manual setting or the free-running setting of the illumination characteristics.

3. The two-level LED security light according to claim **1**, wherein the external control unit is a voltage divider incorporating with power supply detecting device respectively for manual setting and free-running setting, wherein in manual setting the illumination characteristic is set by a DC voltage generated by tuning the voltage divider; wherein in free-running setting the light-emitting unit performs a free-run of one of the first level and the second level illumination by gradually and periodically changing illumination characteristics, wherein the free-run is terminated by a momentary electric power interruption at a time point corresponding to a specific illumination characteristic for setting the illumination characteristic, in such a way, that following the free-running illumination variation, the illumination characteristic of one of the first level and the second level illumination is selected by turning off a power switch instantly and turning it back on at the time point the light-emitting unit performs the specific illumination characteristic; wherein the power switch is connected with the power supply unit for controlling power on and off, wherein, when instantly turning off the power switch and turning it back on, the electric power interruption is detected by the microcontroller through the power supply detecting device for terminating the free-run.

4. The two-level LED security light according to claim **1**, wherein the light emitting unit comprises a plurality of LEDs, the LEDs have identical or different luminous power and color temperature.

5. A two-level security light control device applicable to AC lighting sources, comprising:

a power supply unit;

a light sensing control unit;

a motion sensing unit;

a loading and power control unit;

a zero-crossing detection circuit;

a phase controller; and

an external control unit, coupled with the loading and power control unit;

wherein the phase controller is in-series connected to an AC lighting source and an AC power source; wherein the loading and power control unit comprises a microcontroller with program codes to control a conduction period of the phase controller thereby to adjust the average power of the AC lighting source; wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the AC lighting source is turned on by the loading and power control unit thereby to generate a first level illumination and when the ambient light detected by the light sensing control unit is higher than the predetermined value, the AC lighting source is turned off by the loading and power control unit; when an intrusion is detected by the motion sensing unit, the loading and power control unit changes the average power of the AC lighting source and a second level illumination is generated for a predetermined duration, wherein the first level and the second level illumination are characterized by specific light intensity and/or color temperature;

wherein the external control unit is used in at least one of two setting modes respectively for setting illumination characteristics of one of the first level and the second level illumination; wherein the first setting mode is a manual setting incorporating with the external control unit when the AC lighting source generates one of the first level and the second level illumination, in which the illumination characteristic of the AC lighting source is changed directly by operating the external control unit;

wherein the second setting mode is a free-running setting, in which the AC lighting source performs a free-run of one of the first level and the second level illumination by gradually and periodically changing illumination characteristics, wherein the free-run is terminated by operating the external control unit at a time point corresponding to a specific illumination characteristic, such that, following the free-running illumination variation, the illumination characteristics of one of the first level and the second level illumination is set by operating the external control unit at the time point when the AC lighting source performs the specific illumination characteristic; wherein the AC lighting source performs one of the first level and the second level illumination characterized by the specific illumination characteristic being set thereof.

6. The two-level security light control device according to claim **5**, wherein the external control unit is a push button, a touch panel, an infrared sensor or a wireless remote control device coupled to a pin of the microcontroller of the loading and power control unit;

wherein, when the push button, the touch panel, the infrared sensor or the wireless remote control device is operated, a voltage signal is thereby generated to trigger the microcontroller for the manual setting or the free-running setting of the illumination characteristics.

7. The two-level security light control device according to claim **5**, wherein, for the manual setting, the external control unit is a voltage divider comprising a variable resistor, wherein the variable resistor is connected to a pin of the microcontroller in the loading and power control unit;

wherein a DC voltage is generated by tuning the variable resistor to manually set illumination characteristics.

8. The two-level security light control device according to claim **5**, wherein, for the free-running setting, the AC lighting source performs a free-run of one of the first level and the second level illumination by gradually and periodically changing illumination characteristics, wherein the free-run is terminated by a momentary electric power interruption at a time point corresponding to a specific illumination characteristic for setting the illumination characteristic, in such a way, that following the free-running illumination variation, the illumination characteristic of one of the first level and the second level illumination is selected by turning off a power switch instantly and turning it back on at the time point the AC lighting source performs the specific illumination characteristic; wherein the power switch is in-series connected with the AC power source and, while turning off the power switch instantly, the electric power interruption is detected by the microcontroller through the zero-crossing detection circuit to trigger the loading and power control unit for terminating the free-run.

9. The two-level security light control device according to claim **5**, wherein the AC lighting source is a LED lamp or a plurality of light-emitting diodes.

10. The two-level security light control device according to claim **5**, wherein the AC lighting source is an incandescent lamp.

11. The two-level security light control device according to claim **5**, wherein the AC lighting source is a fluorescent lamp.

12. A two-level security light control device applicable to AC lighting sources, comprising:

a power supply unit;

a light sensing control unit;

a motion sensing unit;

a loading and power control unit;

a zero-crossing detection circuit;

a plurality of phase controllers; and

an external control unit, coupled with the loading and power control unit;

wherein the plurality of phase controllers are respectively series-connected to a plurality of alternating current (AC) lighting sources, wherein the pairs of phase controller-AC lighting source are parallel-connected to an AC power source; wherein the loading and power control unit comprises a microcontroller with program codes to respectively control conduction time periods of the phase controllers thereby to respectively adjust the average powers of the AC lighting sources; wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the AC lighting sources are turned on by the loading and power control unit to generate a first level illumination and when the ambient light detected by the light sensing control unit is higher than the predetermined value, the AC lighting sources are turned off; wherein when an intrusion is detected by the motion sensing unit, the loading and power control unit changes the average power of the AC lighting sources to generate a second level illumination for a predetermined duration, wherein the first level and the second level illumination are characterized by specific light intensity and color temperature;

wherein the external control unit is used in at least one of two setting modes respectively for setting illumination characteristics of one of the first level and the second level illumination; wherein the first setting mode is a manual setting incorporating with the external control unit when the AC lighting sources generates one of the first level and the second level

illumination, in which the illumination characteristics of the AC lighting sources are changed directly by operating the external control unit;

wherein the second setting mode is a free-running setting, in which the AC lighting sources perform a free-run of one of the first level and the second level illumination by gradually and periodically changing illumination characteristics, wherein the free-run is terminated by operating the external control unit at a time point corresponding to specific illumination characteristics, such that, following the free-running illumination variation, the illumination characteristics of one of the first level and the second level illumination is set by operating the external control unit at the time point when the AC lighting sources perform the specific illumination characteristics;

wherein the AC lighting sources perform one of the first level and the second level illumination characterized by the specific illumination characteristics being set thereof.

13. The two-level security light control device according to claim **12**, wherein the first level illumination is characterized by low light intensity and low color temperature and the second level illumination by high light intensity and high color temperature.

14. The two-level security light control device according to claim **12**, wherein the external control unit outputs control signals to the microcontroller for adjusting the illumination level characteristics of the illumination level of the AC lighting source, wherein the microcontroller memorizes the illumination level characteristics when the external control unit completes setting the first level or the second level illumination.

15. The two-level security light control device according to claim **12**, wherein the second setting mode is a free-running setting in which the AC lighting sources perform a free-run of one of the first level and the second level illumination by gradually and periodically changing illumination characteristics, wherein the free-run is terminated by a momentary electric power interruption at a time point corresponding to a specific illumination characteristic for setting the illumination characteristic, in such a way, that following the free-running illumination variation, the illumination characteristics of one of the first level and the second level illumination are selected by turning off a power switch instantly and turning it back on at the time point the AC lighting sources perform the specific illumination characteristics; wherein the power switch is in-series connected with the AC power source and, while turning off the power switch instantly, the electric power interruption triggers the loading and power control unit through the zero-crossing detection circuit to terminate the free-run.

16. The two-level security light control device according to claim **12**, wherein the plurality of alternating current (AC) lighting sources comprise at least one high color temperature light-emitting diode and one low color temperature light-emitting diode.

17. A two-level LED security light, comprising:

a light-emitting unit;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a time setting unit;

a power supply unit; and

an external control unit;

wherein the light-emitting unit comprises at least one LED being in-series connected with a semiconductor switching device and the power supply unit;

wherein the loading and power control unit comprises a microcontroller electrically coupled with the semiconductor

switching device, wherein the microcontroller with program codes outputs a pulse width modulation (PWM) signal to a gate electrode of the semiconductor switching device to control a conduction time period (T_{on}) and a cut-off time period (T_{off}) of the semiconductor switching device for delivering different average electric currents from the power supply unit to drive the light-emitting unit for generating different illuminations, such that the light-emitting unit is controlled by the loading and power control unit to generate illuminations characterized by illumination levels with specific light intensities according to the signals received from the light sensing control unit and the motion sensing unit;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the light-emitting unit is turned on thereby by the loading and power control unit to generate an adjustable level illumination for a first predetermined duration and then turned off or switched to a low level illumination, when an intrusion is detected by the motion sensing unit, the light-emitting unit is turned on by the loading and power control unit to generate a high level illumination for a second predetermined duration and then turned off or switched to a low level illumination until the next intrusion detection; when an ambient light detected by the light sensing control unit is higher than the predetermined value, the light-emitting unit is turned off by the loading and power control unit;

wherein the time setting unit is used to set the first and the second predetermined duration respectively for the adjustable low level illumination and the adjustable high level illumination;

wherein the external control unit is used in at least one of two setting modes for setting illumination characteristics of the adjustable level illumination; wherein the first setting mode is a manual setting, in which the illumination level of the light-emitting unit is set in a preset range by operating the external control unit; wherein the second setting mode is a free-running setting, in which the light-emitting unit performs a free-run of the adjustable level illumination with light intensity gradually and periodically increasing and then decreasing in a preset range to complete a cycle, wherein the free-run is terminated by operating the external control unit at a time point corresponding to a specific light intensity level, such that the light-emitting unit performs the adjustable level illumination constantly with the specific light intensity level being set thereof.

18. A two-level LED security light, comprising:

a light-emitting unit;

a loading and power control unit;

a light sensing control unit;

a time setting unit;

a power supply unit; and

an external control unit;

wherein the light-emitting unit comprises at least one LED being in-series connected with a semiconductor switching device and the power supply unit;

wherein the loading and power control unit comprises a microcontroller electrically coupled with the semiconductor switching device, wherein the microcontroller with program codes outputs a pulse width modulation (PWM) signal to a gate electrode of the semiconductor switching device to control a conduction time period (T_{on}) and a cut-off time period (T_{off}) of the semiconductor switching device for delivering different average electric currents from the power supply unit to drive the light-emitting unit for generating different illuminations, such that the light-emitting unit is controlled by the loading and power control unit to generate illuminations characterized by illumination levels with specific light intensities according to the signals received from the light sensing control unit;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the light-emitting unit is turned on thereby by the loading and power control unit to generate a high level illumination for a predetermined duration and then switched to generate a low level illumination; when an ambient light detected by the light sensing control unit is higher than the predetermined value, the light-emitting unit is turned off by the loading and power control unit;

wherein the time setting unit is used for setting the predetermined duration for the high level illumination;

wherein the external control unit is used for setting at least one of the low level illumination and the high level illumination in a preset range.

19. A two-level LED security light, comprising:

a light-emitting unit;

a loading and power control unit;

a light sensing control unit;

a time setting unit;

a power supply unit; and

an external control unit;

wherein the light-emitting unit comprises at least one LED being in-series connected with a semiconductor switching device and the power supply unit;

wherein the loading and power control unit comprises a microcontroller electrically coupled with the semiconductor switching device, wherein the microcontroller with program codes outputs a pulse width modulation (PWM) signal to a gate electrode of the semiconductor switching device to control a conduction time period (T_{on}) and a cut-off time period (T_{off}) of the semiconductor switching device for delivering different average electric currents from the power supply unit to drive the light-emitting unit for generating different illuminations, such that the light-emitting unit is controlled by the loading and power control unit to generate illuminations characterized by illumination levels with specific light intensities according to the signals received from the light sensing control unit;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the light-emitting unit is turned on thereby by the loading and power control unit to generate a high level illumination and then at a clock time point switched to generate a low level illumination; when an ambient light detected by the light sensing control unit is higher than the predetermined value, the light-emitting unit is turned off by the loading and power control unit;

wherein the time setting unit is used for incorporating with a clock device coupled with the microcontroller for setting the clock time point to begin generation of the low level illumination;

wherein the external control unit is used for setting at least one of the low level illumination and the high level illumination in a preset range.

20. A two-level LED security light, comprising:

a light sensing control unit;

a motion sensing unit;

a time setting unit;

a loading and power control unit;

a light-emitting unit; and

an external control unit, coupled with the loading and power control unit;

wherein the light-emitting unit comprises a semiconductor switching device being series-connected between a lighting

source and a power source; wherein the loading and power control unit comprises a microcontroller with program codes to control the semiconductor switching device thereby to adjust the average power of the lighting source; wherein at dusk when the ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to adjust the average power delivered to the lighting source to generate a high level illumination for a first predetermined duration and then to switch to a low level illumination, when an intrusion is detected by the motion sensing unit, the loading and power control unit increases the average power delivered to the lighting source and a high level illumination is generated for a second predetermined duration and then switched back to the low level illumination; wherein at dawn the ambient light detected by the light sensing control unit is higher than the predetermined value, the loading and power control unit manages to turn off the lighting source;

wherein the time setting unit is used for setting the first and the second predetermined duration;

wherein the external control unit is used for setting at least one of the low level illumination and the high level illumination in a preset range.

21. A two-level LED security light, comprising:

a light sensing control unit;

a motion sensing unit;

a time setting unit;

a loading and power control unit;

a light-emitting unit; and

an external control unit, coupled with the loading and power control unit;

wherein the light-emitting unit comprises a semiconductor switching device being series-connected between a lighting source and a power source; wherein the loading and power control unit comprises a microcontroller with program codes to control the semiconductor switching device thereby to adjust the average power of the lighting source; wherein at dusk when the ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to adjust the average power delivered to the lighting source to generate a high level illumination and then at a clock time point to switch to a low level illumination, when an intrusion is detected by the motion sensing unit, the loading and power control unit increases the average power delivered to the lighting source and a high level illumination is generated for a predetermined duration and then switched back to the low level illumination;

wherein at dawn the ambient light detected by the light sensing control unit is higher than the predetermined value, the loading and power control unit manages to turn off the lighting source;

wherein the time setting unit is used respectively for setting the predetermined duration for the high level illumination and incorporating with a clock device coupled with the microcontroller for setting the clock time point to begin generation of the low level illumination;

wherein the external control unit is used for setting at least one of the low level illumination and the high level illumination in a preset range.

22. A lighting management device applicable to a lighting load comprising:

a loading and power control unit;

a power supply unit; and

an external control unit, coupled with the loading and power control unit;

wherein the loading and power control unit comprises a microcontroller electrically coupled with a semiconductor switching device, wherein the semiconductor switching device is electrically connected in series with the power supply unit and the lighting load, wherein the microcontroller with program codes controls the conduction rate of the semiconductor switching device, wherein the external control unit enables an user to select a desired illumination characteristic during a free running setting process performed by the lighting load, wherein the lighting load operates a free-run of illumination level by gradually and periodically changing the illumination characteristic, wherein the free-run is terminated by operating the external control unit at a time point corresponding to a specific illumination characteristic selected by the user, wherein the microcontroller accordingly interprets the conduction rate of the semiconductor switching device at the time point when the external control unit is operated and the free running is terminated to be the illumination characteristic set for illumination performance, the illumination characteristic is then memorized by the microcontroller for repetitive performance, wherein the illumination characteristic is light intensity, light color temperature or a combination of light intensity and light color temperature.

23. The lighting management device according to claim **22**, wherein the external control unit is a push button, a touch panel, an infrared sensor or a wireless remote control device coupled to a pin of the microcontroller.

24. The lighting management device according to claim **22**, wherein the free run setting is terminated and the illumination characteristic of the lighting load is set by turning off a power switch instantly and turning it back on at the time point the lighting load performs a desired lighting characteristic selected by the user.

25. A free running setting method with an external control unit comprising:

selecting a desired illumination characteristic during a free running setting process performed with a lighting load by an external control unit;

utilizing the lighting load to operate a free-run of illumination level by gradually and periodically changing the desired illumination characteristic;

terminating the free-run by activating the external control unit at a time point corresponding to a specific illumination characteristic selected by an user, wherein a microcontroller is arranged to accordingly interpret a conduction rate of a semiconductor switching device at the time point when the external control unit is operated and the free running is terminated to be an illumination characteristic set for illumination performance, the illumination characteristic set is then memorized by the microcontroller for repetitive performance.

26. The free running setting method with an external control unit according to claim **25**, wherein the free running setting is terminated and the illumination characteristic of the lighting load is set by turning off a power switch instantly and turning it back on at the time point the lighting load performs a desired lighting characteristic selected by the user.

* * * * *

EXHIBIT E

US010225902B2

(12) **United States Patent**
Chen

(10) **Patent No.: US 10,225,902 B2**
(45) **Date of Patent: *Mar. 5, 2019**

(54) **TWO-LEVEL SECURITY LIGHT WITH MOTION SENSOR**

(71) Applicant: **VAXCEL INTERNATIONAL CO., LTD.**, Carol Stream, IL (US)

(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

(73) Assignee: **Vaxcel International Co., Ltd.**, Carol Stream, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/896,403**

(22) Filed: **Feb. 14, 2018**

(65) **Prior Publication Data**

US 2018/0177015 A1 Jun. 21, 2018

Related U.S. Application Data

(60) Continuation of application No. 15/785,658, filed on Oct. 17, 2017, which is a continuation of application

(Continued)

(51) **Int. Cl.**
H05B 37/02 (2006.01)
H05B 33/08 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC ***H05B 33/0854*** (2013.01); ***F21S 9/03*** (2013.01); ***F21V 17/02*** (2013.01); ***G08B 5/36*** (2013.01); ***G08B 13/1895*** (2013.01); ***G08B 15/00*** (2013.01); ***G08B 15/002*** (2013.01); ***H02J 7/35*** (2013.01); ***H05B 33/083*** (2013.01); ***H05B 33/0809*** (2013.01); ***H05B 33/0815*** (2013.01); ***H05B 33/0818*** (2013.01); ***H05B 33/0824*** (2013.01); ***H05B 33/0827*** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC H05B 33/0815; H05B 33/0824; H05B 33/083; H05B 33/0845; H05B 33/0854; H05B 33/0872; H05B 37/0218; H05B 37/0227; H05B 37/0281
USPC 315/149, 152, 154, 307, 308, 312
See application file for complete search history.

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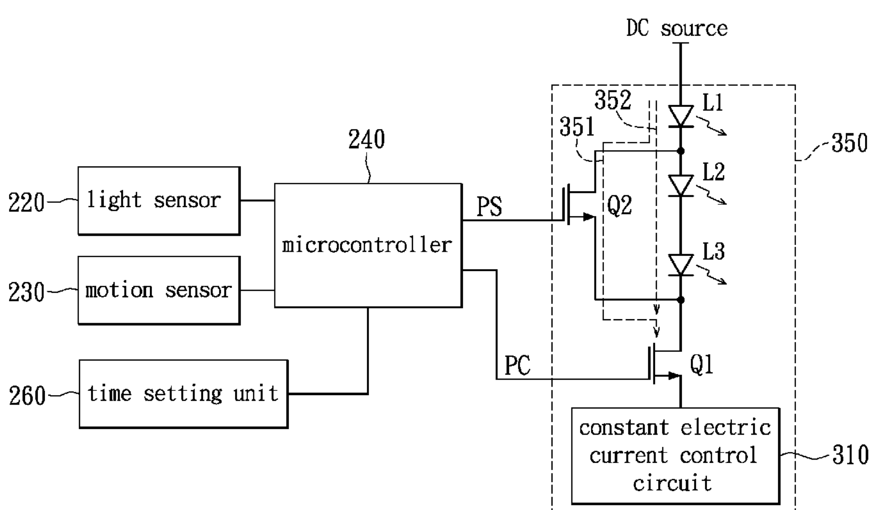
Primary Examiner — Tung X Le
(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A life-style two-level LED security light with a motion sensor. The life-style two-level LED security light includes a light-emitting unit configured with two sets of LEDs respectively emitting different color temperature lights. At night, the light-emitting unit is turned on for a low level illumination with a low color temperature light featuring an ascetic night view. When the motion sensor detects a motion intrusion, the light-emitting unit is switched from the low level illumination with the low color temperature light to a high level illumination with a high color temperature light to perform a dual effect of security alert and to enable an occupant to have a high visibility of the surrounding environment when needed. The low level illumination also creates a light house effect to help an occupant move toward a destination without encountering an accident or getting lost.

34 Claims, 18 Drawing Sheets



Related U.S. Application Data

No. 15/375,777, filed on Dec. 12, 2016, now Pat. No. 9,826,590, which is a continuation of application No. 14/836,000, filed on Aug. 26, 2015, now Pat. No. 9,622,325, which is a division of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

(51) **Int. Cl.**

G08B 15/00	(2006.01)
H05B 39/04	(2006.01)
F21S 9/03	(2006.01)
F21V 17/02	(2006.01)
G08B 5/36	(2006.01)
G08B 13/189	(2006.01)
H02J 7/35	(2006.01)
F21Y 115/10	(2016.01)
G08B 13/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H05B 33/0872*** (2013.01); ***H05B 37/02*** (2013.01); ***H05B 37/0218*** (2013.01); ***H05B 37/0227*** (2013.01); ***H05B 37/0281*** (2013.01); ***H05B 39/042*** (2013.01); ***H05B 39/044*** (2013.01); *F21Y 2115/10* (2016.08); *G08B 13/00* (2013.01); *G08B 13/189* (2013.01); *Y02B 20/40* (2013.01); *Y02B 20/44* (2013.01); *Y02B 20/46* (2013.01)

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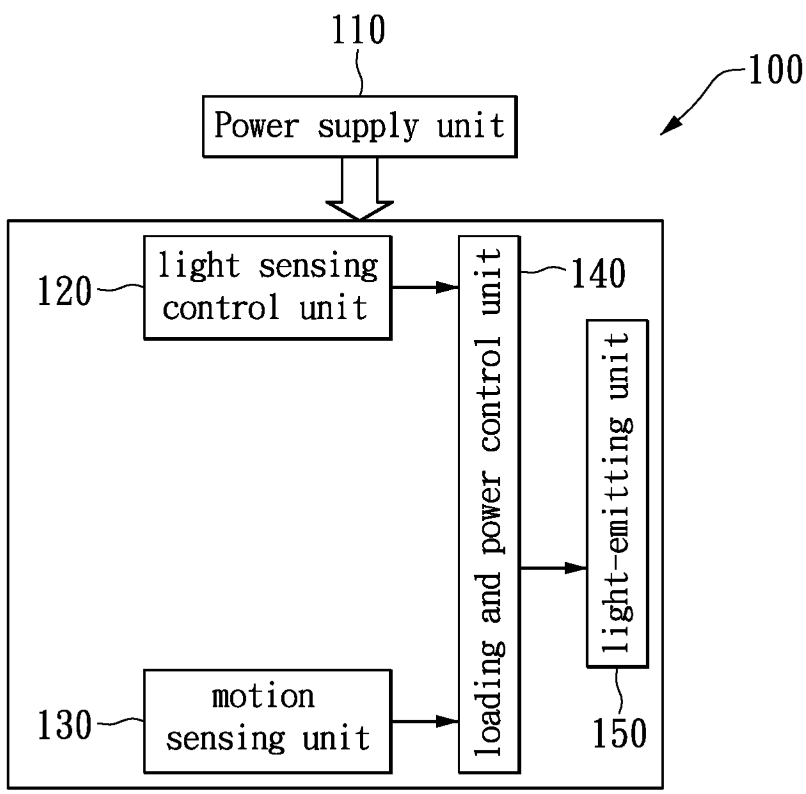
110
100
Power supply unit
light sensing control unit
120
140
loading and power control unit
light-emitting unit
130
motion sensing unit
150

FIG. 1

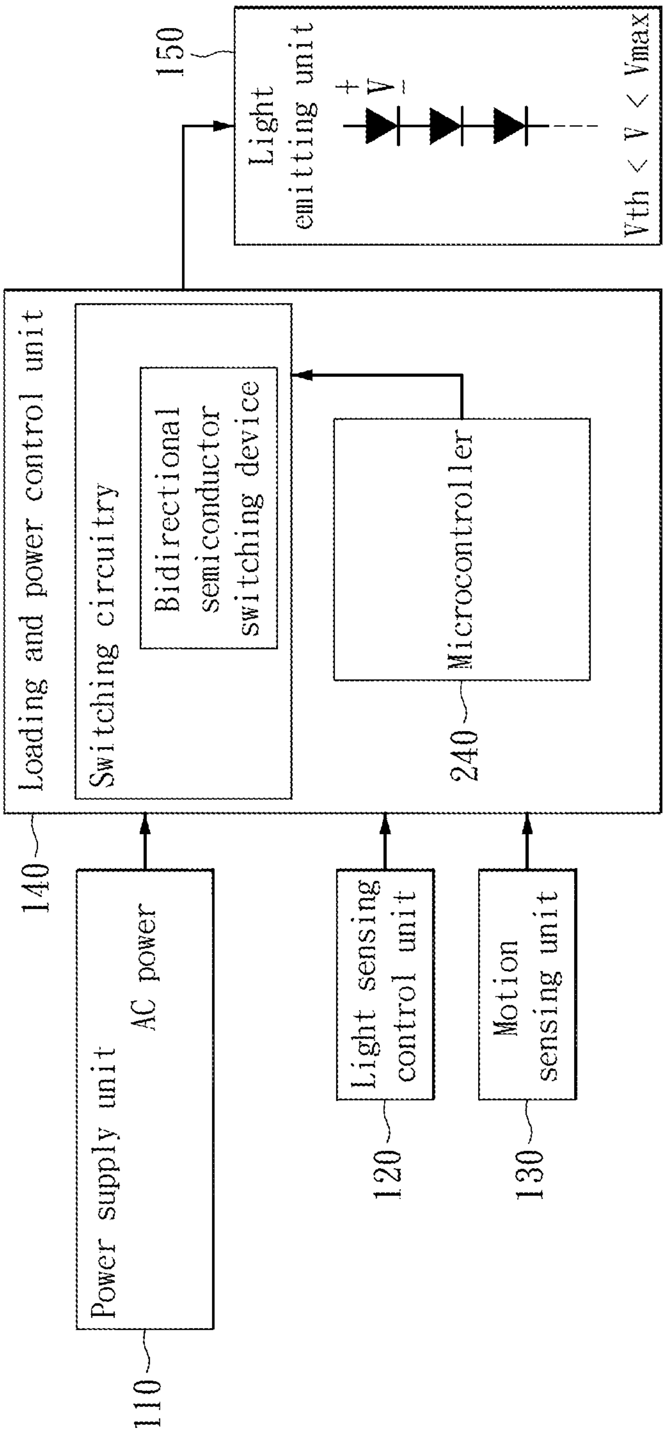
150
Light emitting unit
+ V −
Vth < V < Vmax
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
Light sensing control unit
Motion sensing unit
110
120
130

FIG. 1A

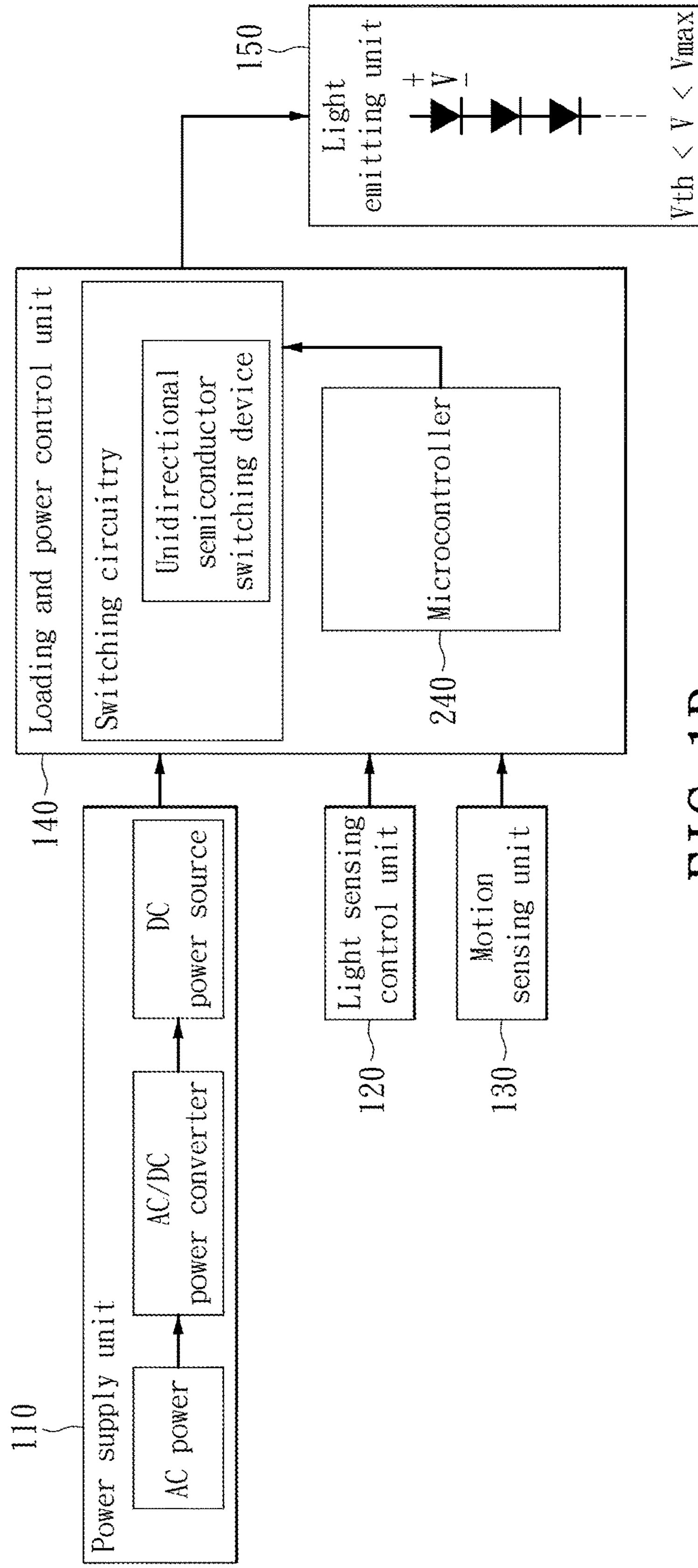
110
Power supply unit
AC power
AC/DC power converter
DC power source
140
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
120
Light sensing control unit
130
Motion sensing unit
150
Light emitting unit
+ V −
Vth < V < Vmax

FIG. 1B

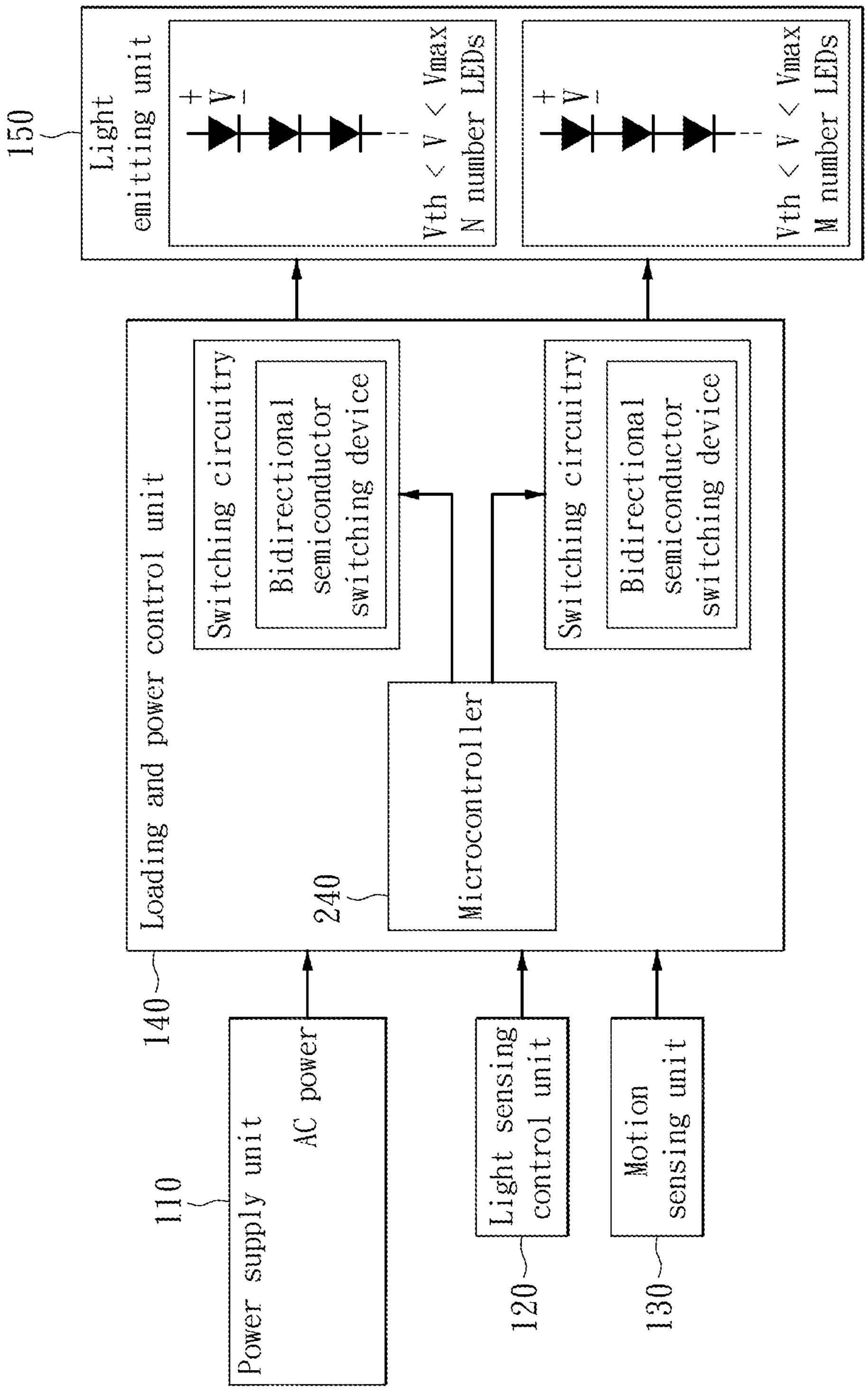
150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Switching circuitry
Bidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
Light sensing control unit
120
Motion sensing unit
130

FIG. 1C

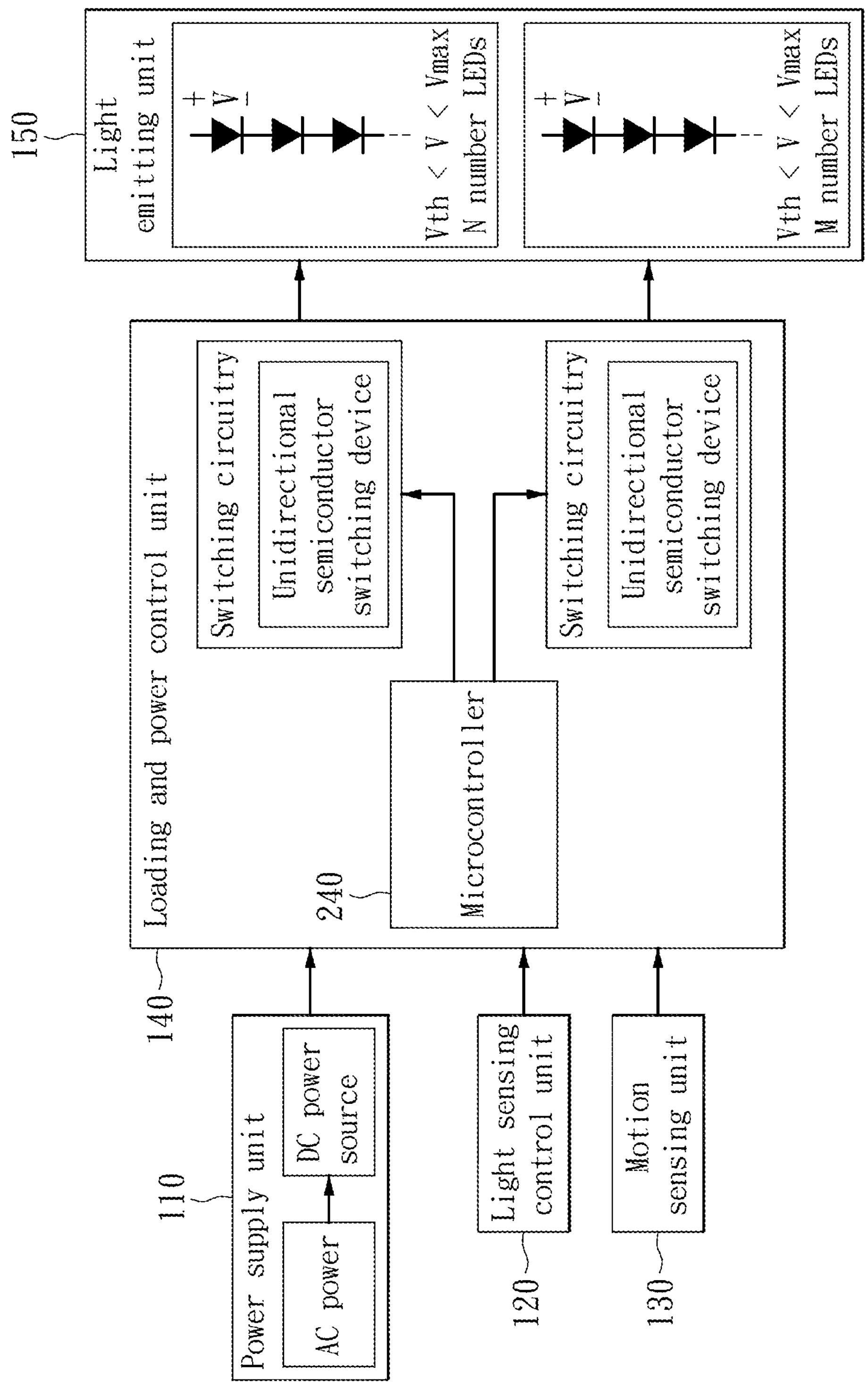
150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Switching circuitry
Unidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
DC power source
Light sensing control unit
120
Motion sensing unit
130

FIG. 1D

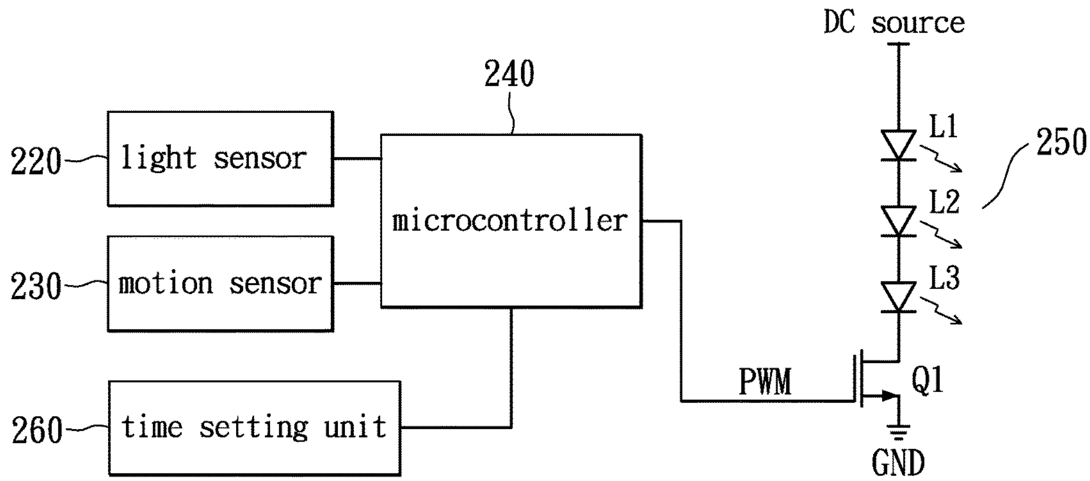
DC source
240
220
light sensor
microcontroller
L1
L2
L3
250
230
motion sensor
PWM
Q1
260
time setting unit
GND

FIG. 2A

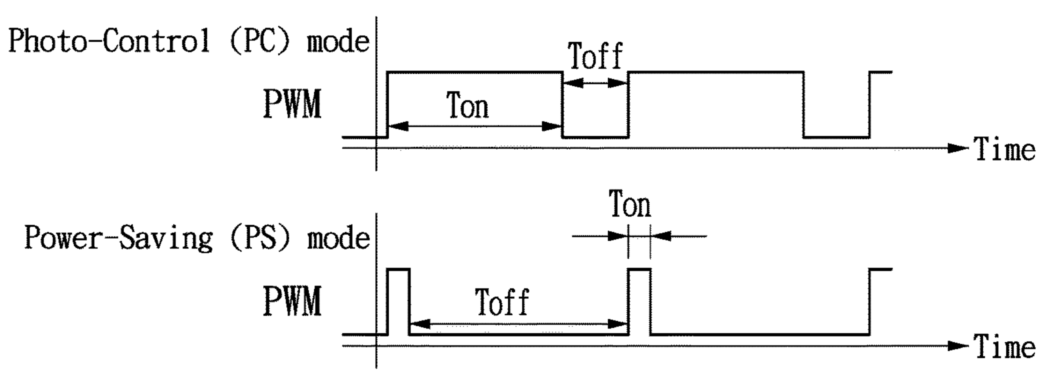
Photo-Control (PC) mode
PWM
Toff
Ton
Time
Power-Saving (PS) mode
Ton
PWM
Toff
Time

FIG. 2B

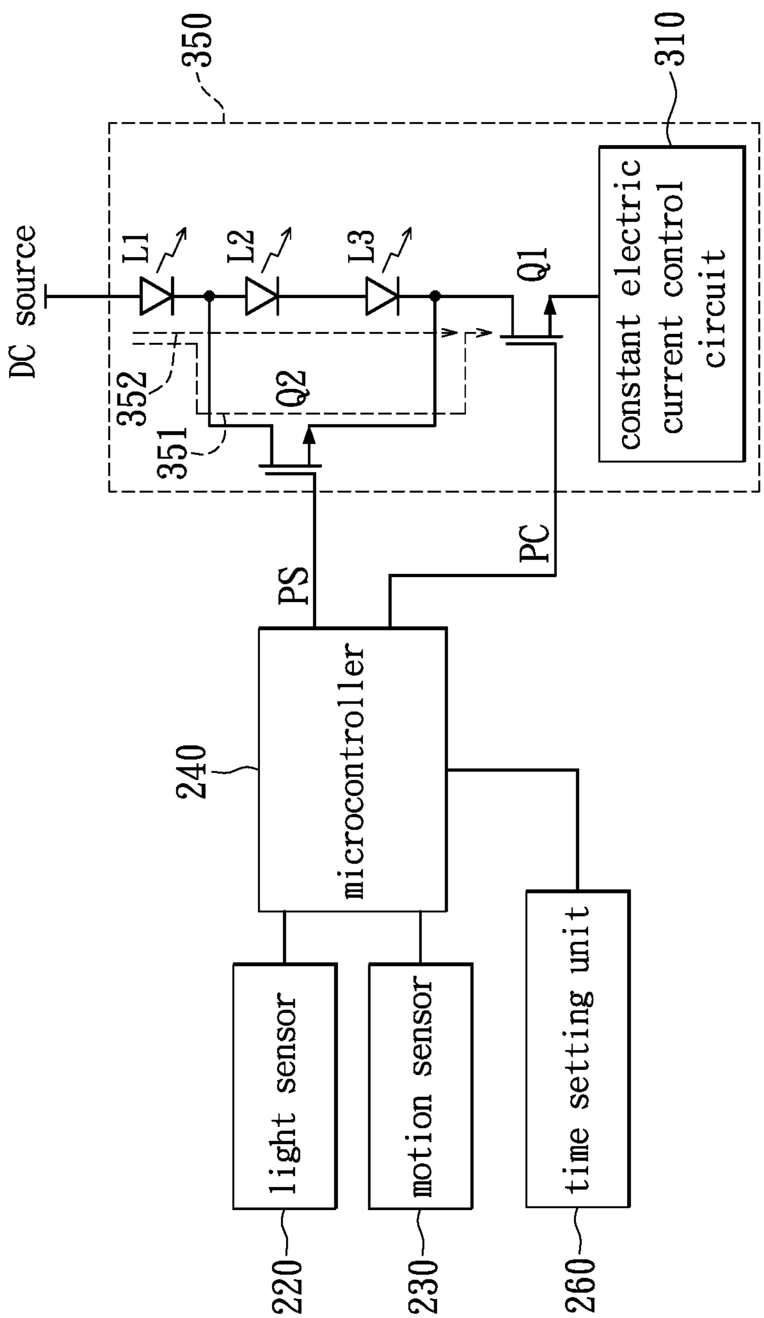
350
310
DC source
L1
L2
L3
Q1
352
351
Q2
constant electric current control circuit
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

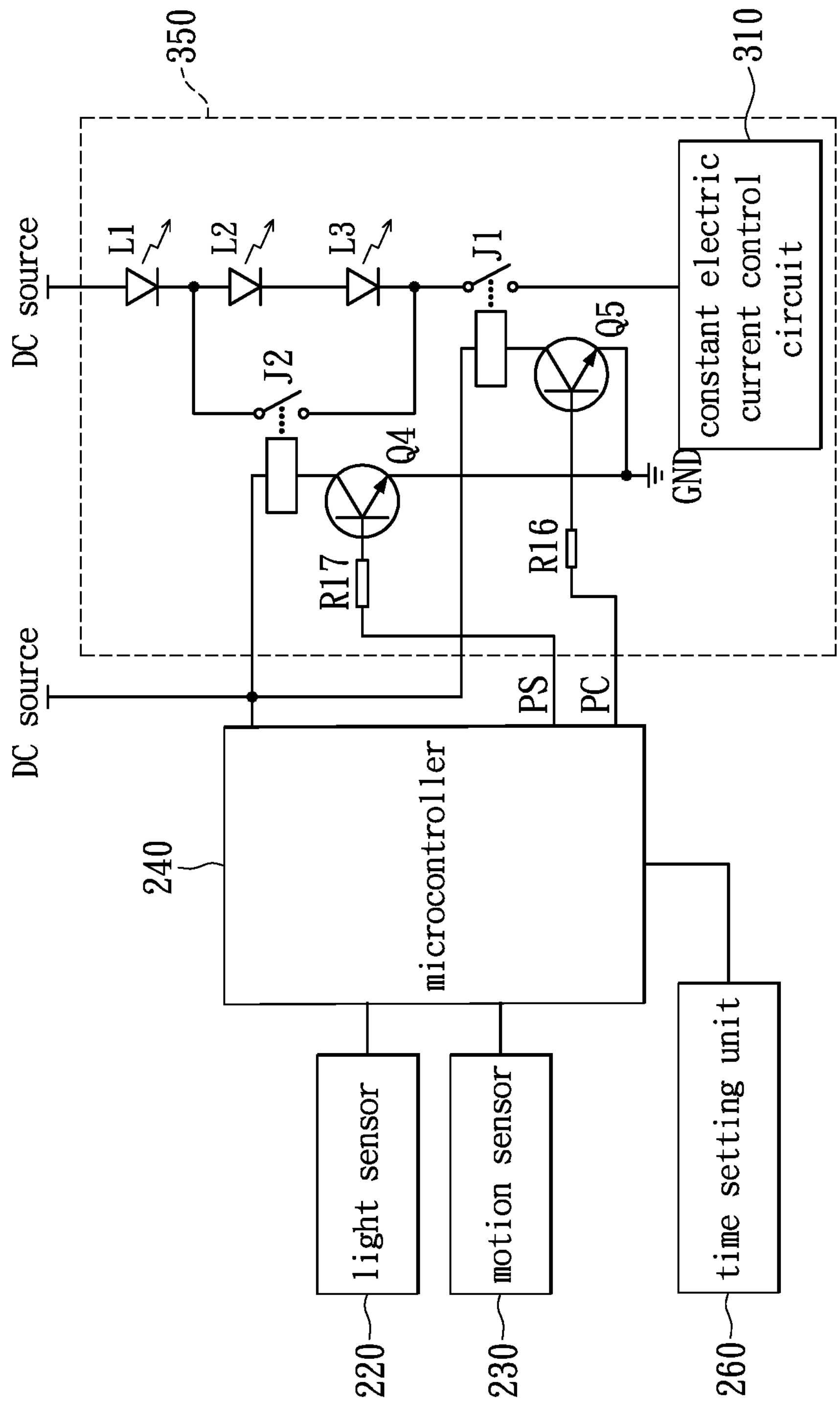
350
310
DC source
L1
L2
L3
J1
J2
Q4
Q5
GND
R16
R17
constant electric current control circuit
DC source
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

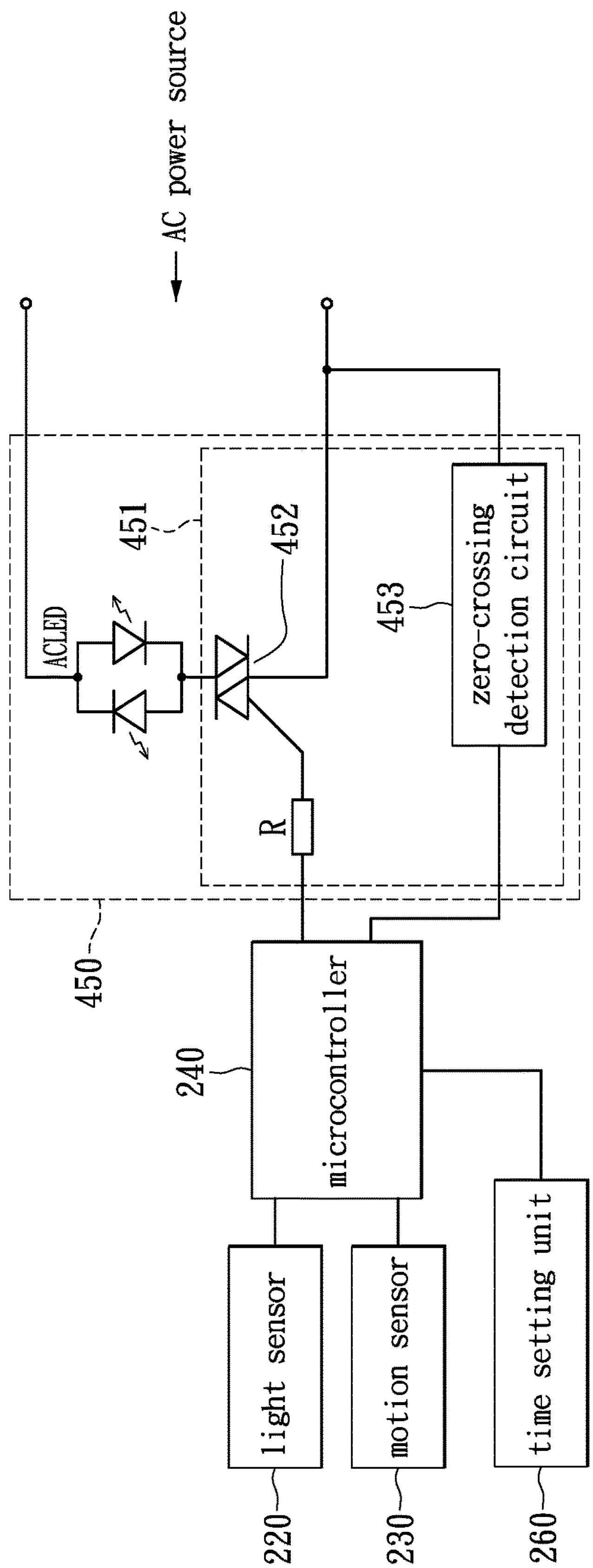
AC power source
ACLED
451
452
453
zero-crossing detection circuit
R
450
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

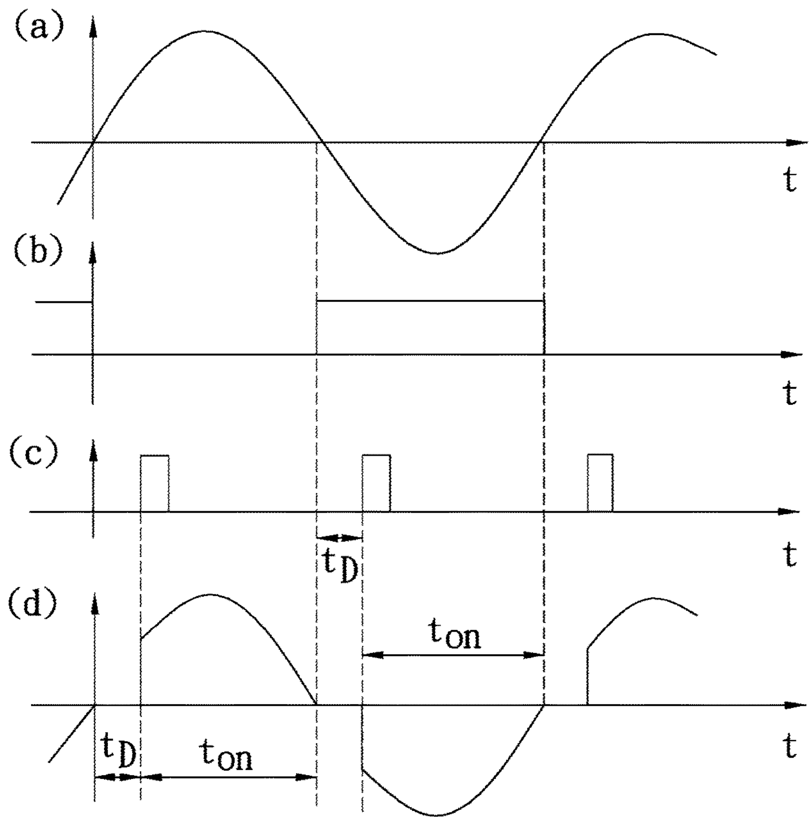

FIG. 4B

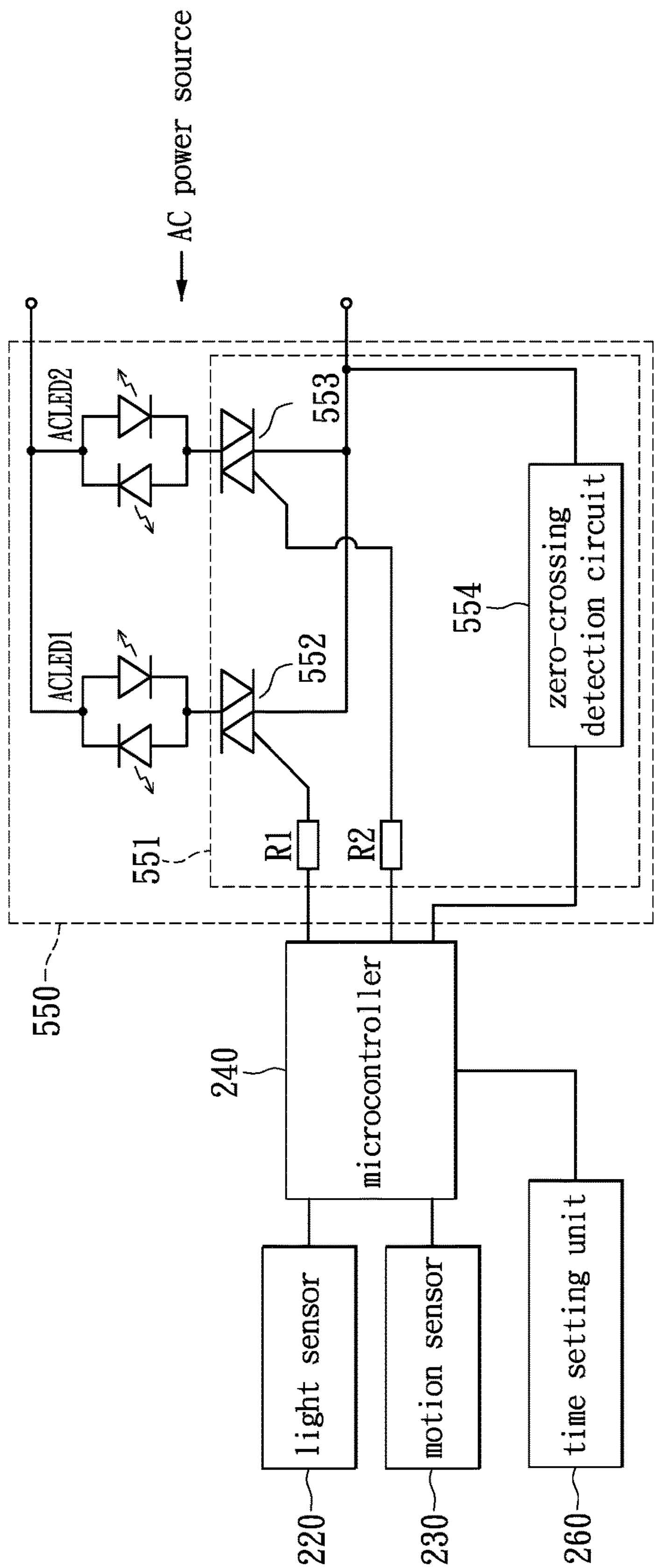
AC power source
ACLED2
ACLED1
553
552
551
554
zero-crossing detection circuit
R1
R2
550
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

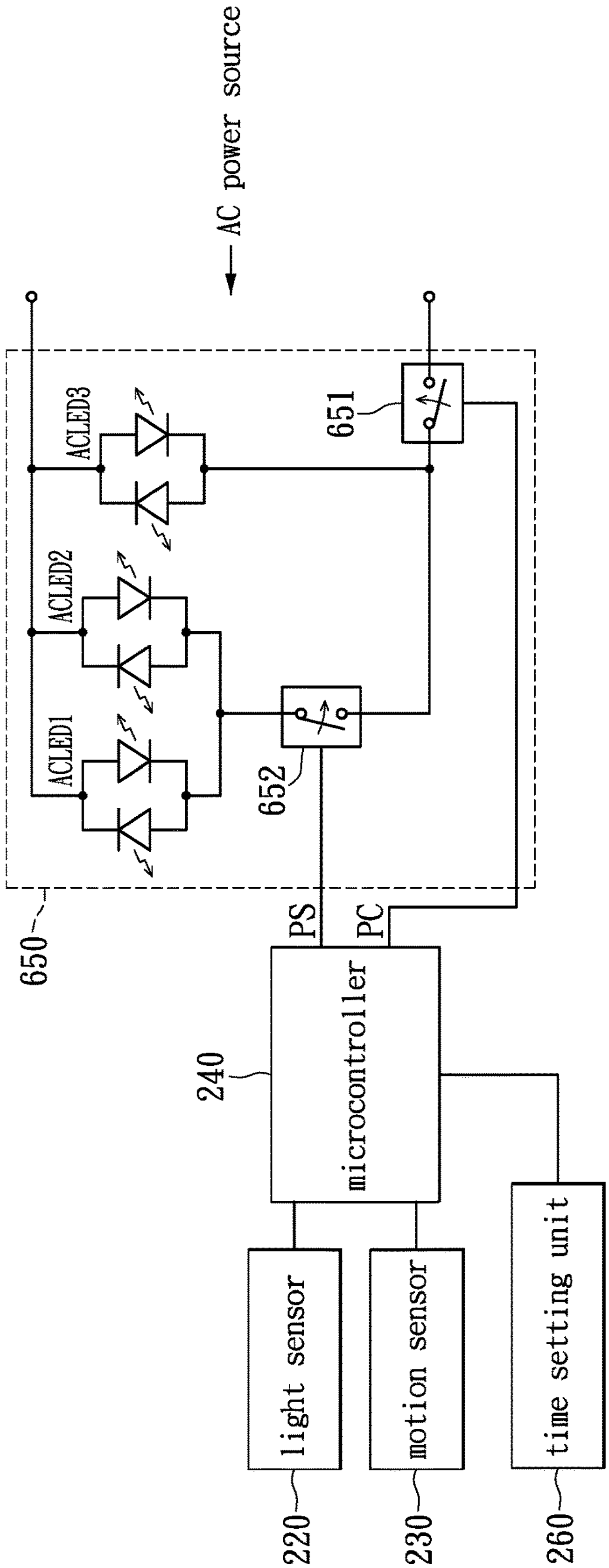
AC power source
ACLED3
ACLED2
ACLED1
651
652
650
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

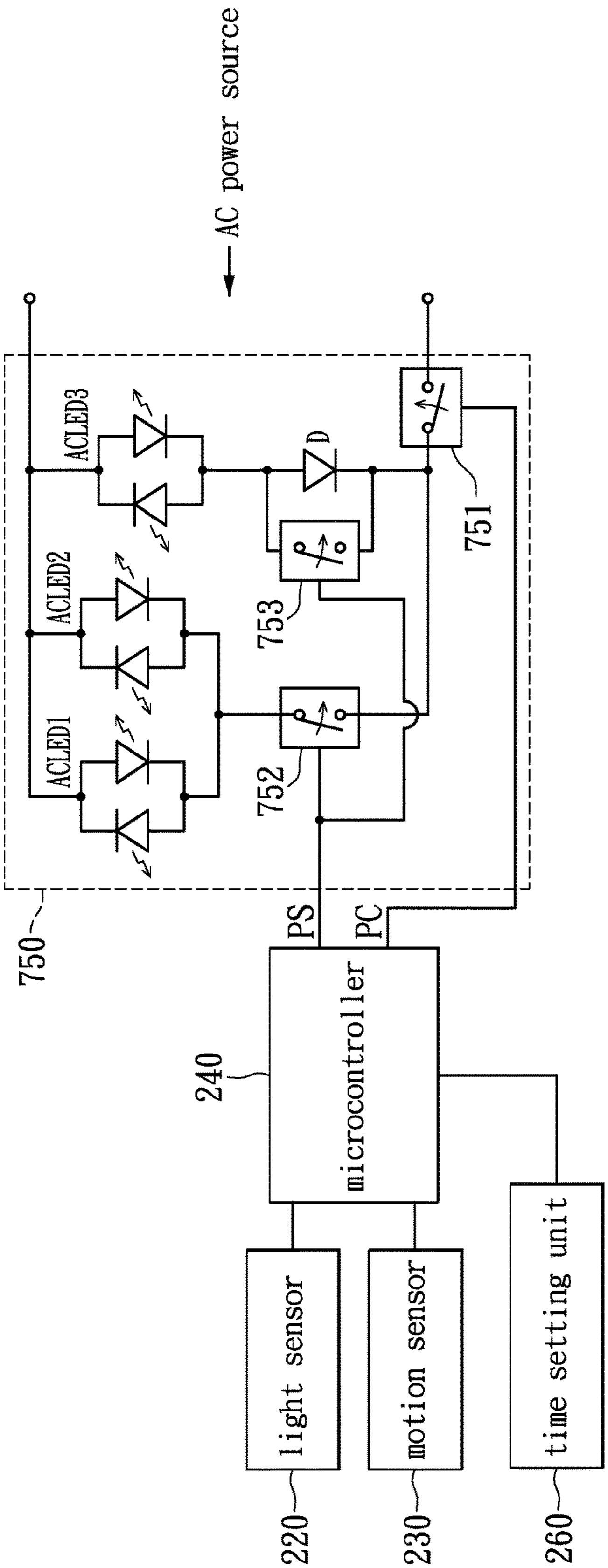
AC power source
ACLED3
ACLED2
ACLED1
D
751
753
752
750
PS
PC
microcontroller
240
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

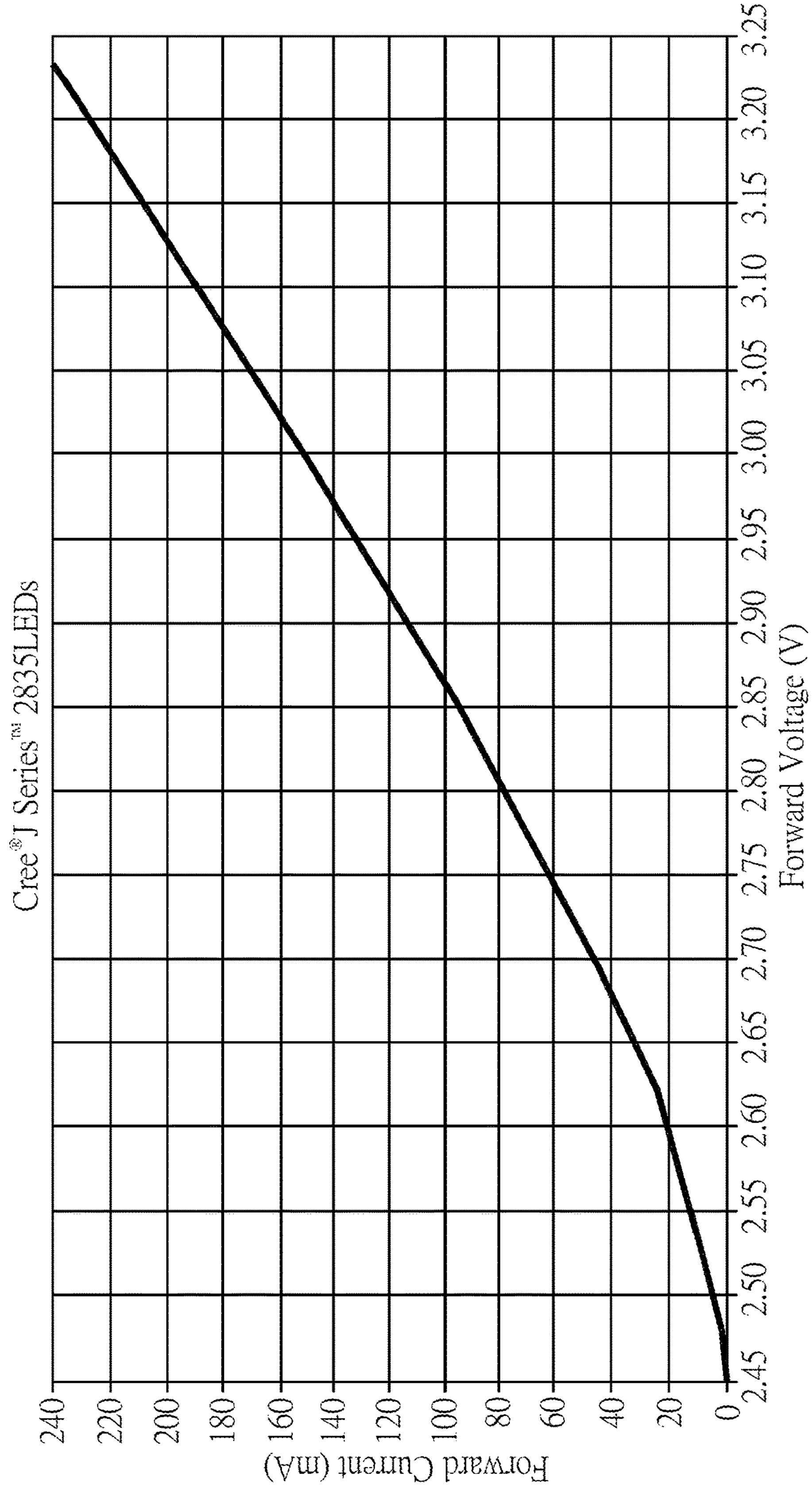
Cree® J Series™ 2835LEDs
Forward Current (mA)
240
220
200
180
160
140
120
100
80
60
40
20
0
Forward Voltage (V)
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25

FIG. 8A

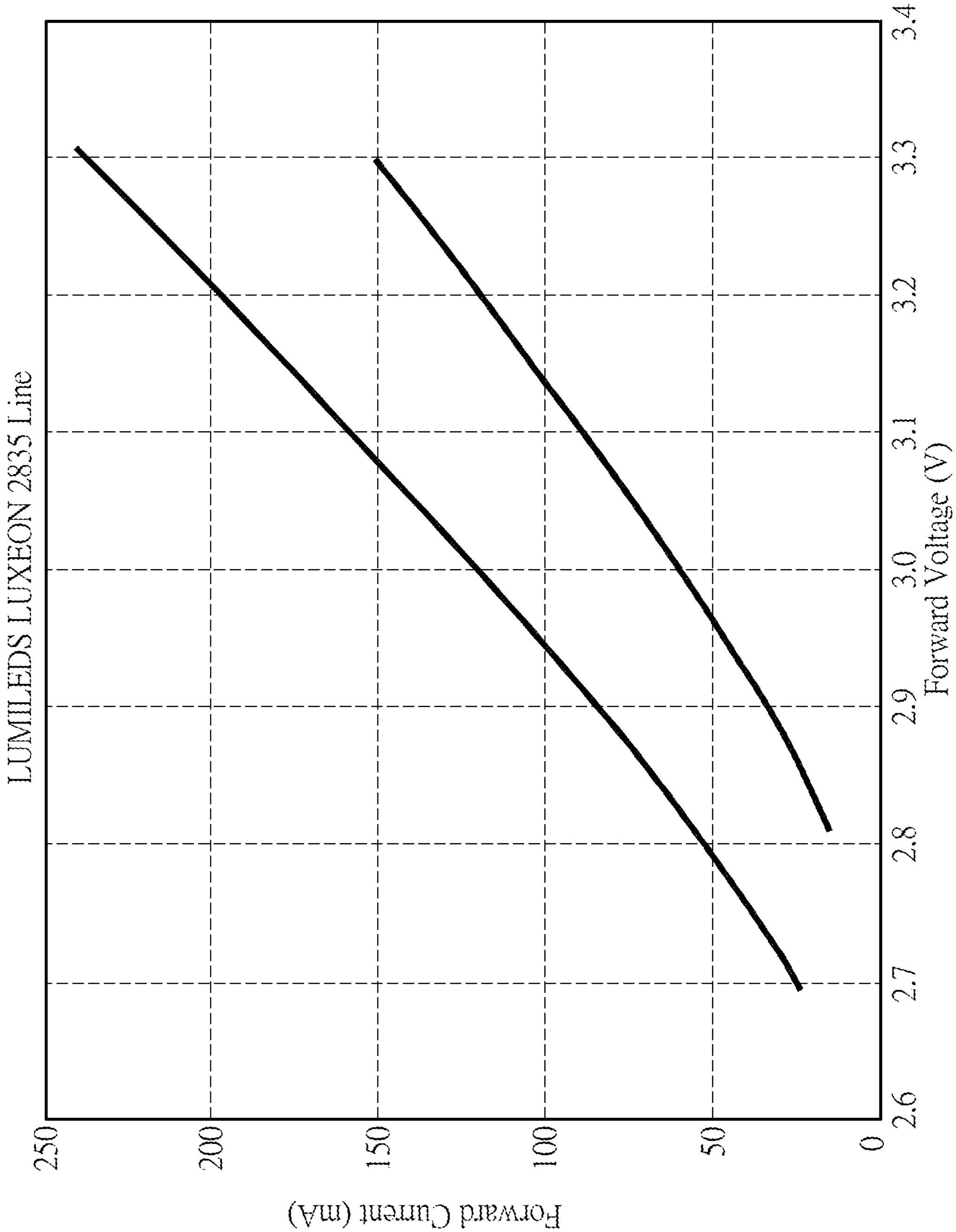
LUMILEDS LUXEON 2835 Line
Forward Current (mA)
250
200
150
100
50
0
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4

FIG. 8B

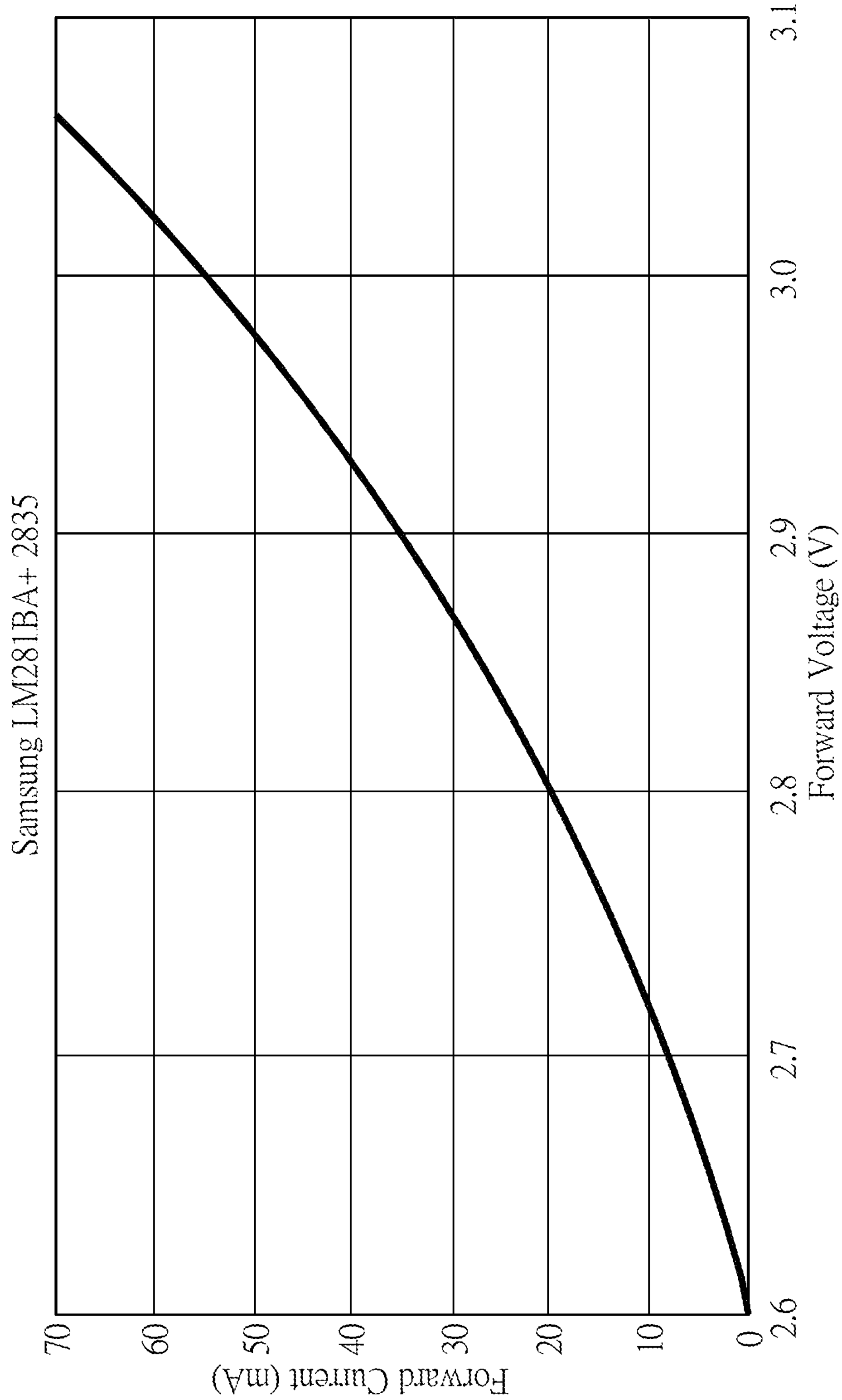
Samsung LM281BA+ 2835
Forward Current (mA)
0
10
20
30
40
50
60
70
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1

FIG. 8C

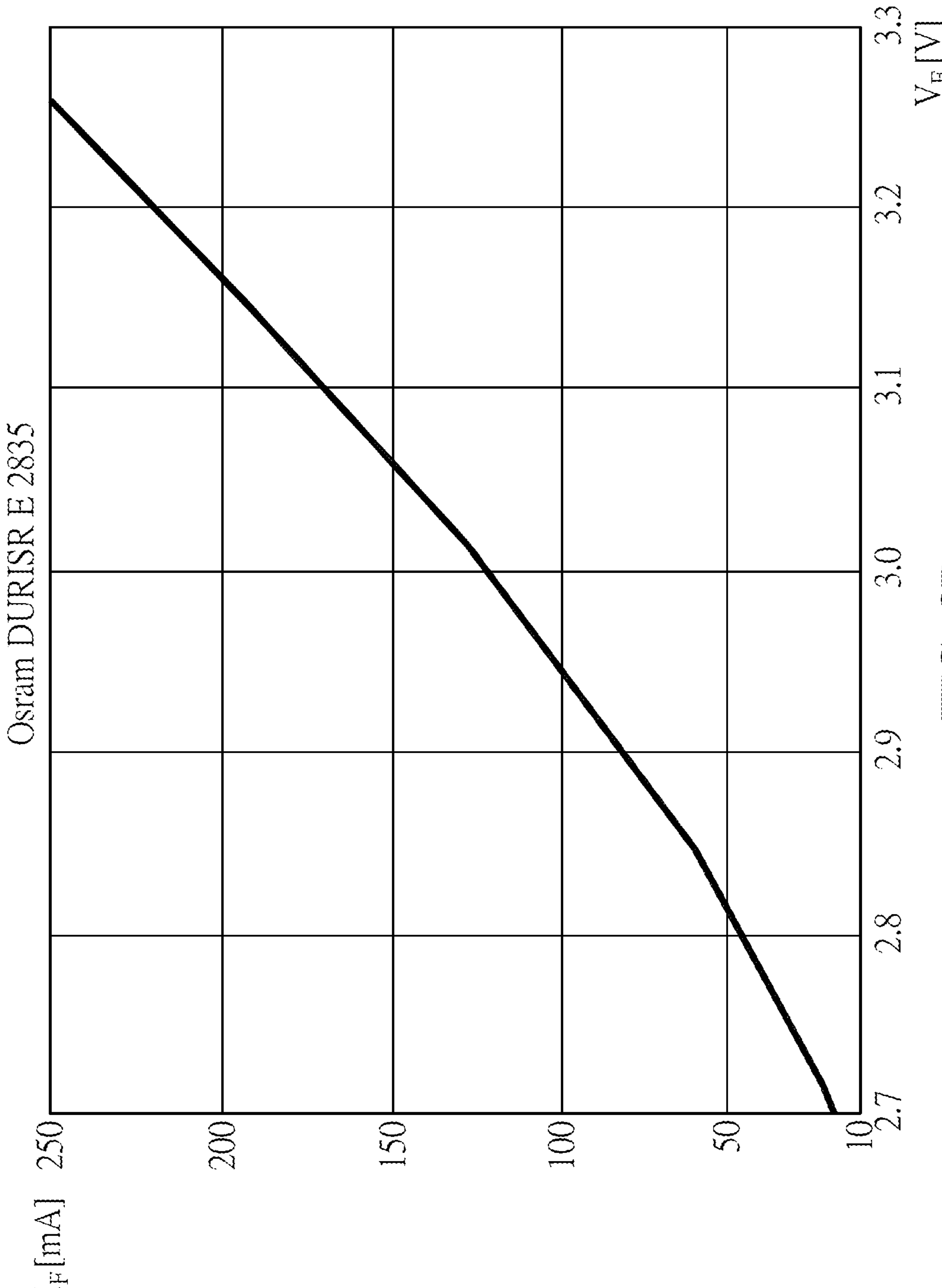
Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
2.7
2.8
2.9
3.0
3.1
3.2
3.3
V_F [V]

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

TWO-LEVEL SECURITY LIGHT WITH MOTION SENSOR

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation application of prior application Ser. No. 15/785,658, filed on Oct. 17, 2017, currently pending. Ser. No. 15/785,658 is a continuation application of U.S. Pat. No. 9,826,590, filed on Dec. 12, 2016. U.S. Pat. No. 9,826,590 is a continuation application of prior application Ser. No. 14/836,000 filed on Aug. 26, 2015, which issued as U.S. Pat. No. 9,622,325, and which is a divisional application of Ser. No. 14/478,150, filed on Sep. 5, 2014, and entitled A TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR, issued as U.S. Pat. No. 9,445,474, which is a continuation application of Ser. No. 13/222,090, filed Aug. 31, 2011, which issued as U.S. Pat. No. 8,866,392 on Oct. 21, 2014.

BACKGROUND OF THE INVENTION

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photoresistors—are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY OF THE INVENTION

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a phase controller and one or a plurality of parallel-connected alternating current (AC)LEDs. The phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that the ambient

light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto-turnoff at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediate switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an AC LED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the AC LED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **1**C is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a AC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises bidirectional semiconductor switching devices for controlling an average electric power to be delivered to the AC LED.

FIG. **1**D is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises unidirectional semiconductor switching devices for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C and **8**D schematically and respectively show I-V relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. 9 is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. A two-level LED security light (herein as the lighting apparatus)**100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs and switching components. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that the ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flow through the light-emitting unit **150**, to generate the high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein the DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a pulse width modulation (PWM) signal to the gate of transistor Q**1** to control the average electric current. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{off} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow the user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. **3**A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A

and FIG. 2A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** detects that the ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may include a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include a phase controller and one or more parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** includes a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger the triac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal

through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<\frac{1}{2f}-t_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(\frac{1}{2\pi f})\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t (rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (½ f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D<6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(*b*). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(*c*), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(*d*) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**, and a phase controller **551**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLEDs and more than one bi-directional switching devices. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1**~**3** having identical luminous power as well as switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1**~**3** are coupled to the AC power source and the light-emitting unit **650** may

generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED**3** is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ALCED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1~3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751~753** to render ACLED**1~3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs. In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

When the light source of the light emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of a voltage operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the voltage operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the threshold voltage and the maximum working voltage.

In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as the threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is the threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the threshold voltage into a corresponding time phase of AC power for lighting control, it is necessary to use the term V_{th} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V is a voltage across the LED chip, V_{th} is the threshold voltage to enable the LED chip to start

emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working Voltage V of each single LED chip is required to operate in a domain between a threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage V_N of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a threshold voltage of N times V_{th} ($N \times V_{th}$) and a maximum working voltage of N times V_{max} ($N \times V_{max}$) or $N \times V_{th}<V_N<N \times V_{max}$, wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V_N across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N \times V_{th}<V_N<N \times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises 4 drawings schematically and respectively showing a I-V relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage. i.e., the threshold voltage or the cut-in voltage, and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers. The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount, of monetary relief was claimed with the Court in the complaint.

The present disclosure of a two-level LED security light provides a unique life-style lighting solution. The motivation of creating such life-style lighting solution has less to do with the energy saving aspect of the low level illumination mode because an LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the life-style lighting solution of the present disclosure is featured with two innovations which meaningfully improve the exquisite tastes of living in the evening, the first innovation is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination with a low color temperature which is necessary for creating a soft and aesthetic night scene for the outdoor living area (such soft and aesthetic night view is not achievable by the high level illumination however), the second innovation is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without getting lost or encountering an accident, wherein when a motion intrusion is detected by the motion sensor the security light is instantly changed to perform a high level illumination mode with a high color temperature light which offers people a high visibility of the surrounding environment when needed. For the visibility of a surrounding environment the high color temperature light is the winner while for the creation of a soft and aesthetic night view there is no substitute for the low color temperature light. It is the innovation of the present invention to configure a life-style security light with a low color temperature LED load and a high color temperature LED load respectively activated by a photo sensor and a motion sensor to resemble the natural phenomenon of a sun light. These two innovative functions ideally implemented by the LED loads coupled with the motion sensor to increase illumination with a high visibility when people enters into the short detection area make the

present invention a perfect life-style lighting solution for enjoying an exquisite taste of evening life.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A life-style two-level LED security light comprising:

a light-emitting unit configured with an LED load;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the light-emitting unit includes a plurality of LEDs divided into two sets with a first set having N number LEDs and a second set having M number LEDs;

wherein the loading and power control unit includes a controller electrically coupled to the light sensing unit, the motion sensing unit and at least two switching devices including at least a first switching device and a second switching device;

wherein the first switching device and the second switching device are connected with the first set of N number LEDs and the second set of M number LEDs, wherein the first switching device and the second switching device are controlled by the controller to be conducting or cut-off to perform at least a first switching mode and a second switching mode;

wherein in the first switching mode the power supply unit drives at least the first set of N number LEDs to perform a low level illumination with low light intensity and in the second switching mode the power supply unit drives at least the second set of M number LEDs to perform a high level illumination with high light intensity;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to turn on the first set of N number LEDs in the light-emitting unit to generate the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than the predetermined value, the light-emitting unit is switched off;

wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to turn on at least the second set of M number LEDs to generate the high level illumination for a predetermined duration before resuming to the low level illumination; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

2. The life-style two-level LED security light according to claim 1, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit continues to turn on the first set of N number LEDs.

3. The life-style two-level LED security light according to claim 1, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit manages to turn off the first set of N number LEDs.

4. The life-style two-level LED security light according to claim 1, wherein the N number LEDs and the M number LEDs are non-detachably coupled to the switching devices.

5. The life-style two-level LED security light according to claim 1, wherein the total wattage of the M number LEDs is greater than the total wattage of the N number LEDs.

6. The life-style two-level LED security light according to claim 1, wherein the total wattage of the M number LEDs is equal to the total wattage of the N number LEDs.

7. The life-style two-level LED security light according to claim 1, wherein the power supply unit outputs a DC power for operating the two-level LED security light, wherein the first set of N number LEDs and the second set of M number LEDs are connected in series, wherein a constant current control circuit is connected in series with the light-emitting unit to convert the DC power into the constant current such that the current level remains stable in light of a drastic change of lighting load between driving the N number LEDs for generating the low level illumination and driving the M number LEDs for generating the high level illumination, wherein the level of constant current is designed such that a voltage across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction.

8. The life-style two-level LED security light according to claim 7,

wherein when the two-level LED security is operated in the low level illumination mode, the light intensity is further adjustable by the controller;

wherein the first set of N number LEDs is configured to include a plurality of switching devices respectively coupled to the two ends of each LED and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the N number LEDs through bypassing unwanted LEDs in the N number LEDs respectively with the associated switching device(s) according, to an external control signal played by an user or according to a value of a voltage divider set by the user.

9. The life-style two-level LED security light according to claim 7, wherein when the two-level LED security is in the high level illumination mode, the light intensity is further adjustable by the controller, wherein the second set of M number LEDs is configured to include a plurality of switching devices respectively coupled to the two ends of each LED and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the M number LEDs through bypassing unwanted LEDs in the M number LEDs respectively with the associated switching device(s) according to an external control signal played by an user or according to a value of a voltage divider set by the user.

10. The life-style two-level LED security light according to claim 1,

wherein the power supply unit outputs a DC power for operating the two-level LED security light;

wherein the first set of N number LEDs and the second set of M number LEDs are connected in parallel, wherein the first switching device is electrically connected in series between the first set of N number LEDs and the power supply unit, wherein the second switching

device is electrically connected in series between the second set of M number LEDs and the power supply unit;

wherein the first set of N number LEDs and the second set of M number LEDs in conjunction with the power supply unit are respectively designed with a configuration of in series and in parallel connections of LEDs such that e an electric current passing through each LED of the light emitting unit remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction.

11. The life-style two-level LED security light according, to claim **10**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

12. The life-style two-level LED security light according to claim **10**, wherein when the two-level LED security light is in the low level illumination mode, the light intensity of the low level illumination mode is further adjustable by the controller; wherein the controller in response to an external control signal played by an user outputs a PWM signal to control a time length of conduction period of the first switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light: emitting unit for performing a dimming work of the low level illumination mode.

13. The life-style two-level LED security light according to claim **10**, wherein when the two-level LED security light is in the high level illumination mode, an illumination of the high level illumination mode is further adjustable by the controller; wherein the controller in response to an external control signal played by an user outputs at least a PWM signal to control a time length of conduction period of at least the second switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing the illumination of the high level illumination mode.

14. The life-style two-level LED security light according to claim **10**, wherein when the two-level LED security light is in the high level illumination mode, an illumination of the high level illumination mode is further adjustable by the controller; wherein the controller in response to an external control signal played by an user outputs PWM signals to control time lengths of conduction period of both the first switching device and the second switching device in each duty cycle such that average electric currents proportional to the time lengths of the conduction period are delivered to the light emitting unit for performing the illumination of the high level illumination mode.

15. A life-style two-level LED security light comprising:

a light-emitting unit configured with an LED load;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the LED load of the light-emitting unit includes a plurality of LEDs divided into two sets with the first set having N number LEDs and the second set having M number LEDs;

wherein the loading and power control unit includes a microcontroller electrically coupled to the light sensing unit, the motion sensing unit and at least two switching devices including a first switching device and a second switching device;

wherein the first switching device and the second switching device are connected with the first set of N number LEDs and the second set of M number LEDs;

wherein the two switching devices are controlled by the microcontroller to be respectively conducting or cut-off to perform at least a first switching mode and a second switching mode;

wherein in the first switching mode at least the first set of N number LEDs is turned on to perform a low level illumination with low light intensity and in the second switching mode at least the second set of M number LEDs is turned on to perform a high level illumination with high light intensity;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to turn on the first set of N number LEDs in the light-emitting unit to generate the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than the predetermined value, the LED load is switched off;

wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to turn on at least the second set of M number LEDs in the light-emitting unit to generate the high level illumination for a predetermined duration; and

wherein the N number LEDs emit light with a low color temperature to produce a soft evening light to feature an aesthetic night view around the living area both for indoor and outdoor need while at the same time create a navigation capacity similar to a light house to help people move to a destination without getting lost or encountering an accident, wherein the M number LEDs emit light with a high color temperature to produce a much brighter day light with a dual effect of security alert by means of creating drastic changes in both light intensity from low to high and light color temperature from warm to cool upon detecting a motion intrusion, wherein the high level illumination with a day light high color temperature enables people to have a high visibility of the surrounding environment when needed.

16. The life-style two-level LED security light according to claim **15**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit continues to turn on the first set of N number LEDs.

17. The life-style two-level LED security light according to claim **15**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit manages to turn off the first set of N number LEDs.

18. The life-style two-level LED security light according to claim **15**, wherein the total wattage of the M number LEDs is greater than the total wattage of the N number LEDs.

19. The life-style two-level LED security light according to claim **15**, wherein the total wattage of the M number LEDs is equal to the total wattage of the N number LEDs.

20. The life-style two-level LED security light according to claim 15, wherein the power supply unit outputs a DC power for operating the life-style two-level LED security light, wherein the first set of N number LEDs and the second set of M number LEDs are connected in series, wherein a constant current control circuit is connected in series with the light-emitting unit to convert the DC power into the constant current such that a current level remains stable in light of a drastic change of lighting load between driving the N number LEDs for generating the low level illumination and driving the M number LEDs for generating the high level illumination, wherein the current level of constant current is designed such that a voltage across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction.

21. The life-style two-level LED security light according to claim 20,

wherein when the life-style two-level LED security is operated in the low level illumination mode, the light intensity is further adjustable by the microcontroller;

wherein the first set of N number LEDs is configured to include a plurality of switching devices respectively coupled to the two ends of each LED and to the microcontroller, wherein the microcontroller is configured to control the number of LEDs to be turned on in the N number LEDs through bypassing unwanted LEDs in the N number LEDs respectively with the associated switching device(s) according to an external control signal played by an user or according to a value of a voltage divider set by the user.

22. The life-style two-level LED security light according to claim 20, wherein when the two-level LED security is in the high level illumination mode, the light intensity is further adjustable by the microcontroller, wherein the second set of M number LEDs is configured to include a plurality of switching devices respectively coupled to the two ends of each LED and to the microcontroller, wherein the microcontroller is configured to control the number of LEDs to be turned on in the M number LEDs through bypassing unwanted LEDs in the M number LEDs respectively with the associated switching device(s) according to an external control signal played by an user or according to a value of a voltage divider set by the user.

23. The life-style two-level LED security light according to claim 15,

wherein the power supply unit outputs a DC power for operating the two-level LED security light;

wherein the first set of N number LEDs and the second set of M number LEDs are connected in parallel, wherein the first switching device is electrically connected in series between the first set of N number LEDs and the power supply unit, wherein the second switching device is electrically connected in series between the second set of M number LEDs and the power supply unit;

wherein the first set of N number LEDs and the second set of M number LEDs in conjunction with the power supply unit are respectively designed such that an electric current passing through each LED of the light-emitting unit remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction.

24. The life-style two-level LED security light according to claim 23, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

25. The life-style two-level LED security light according to claim 23, wherein when the life-style two-level LED security light is in the low level illumination mode, the light intensity of the low level illumination mode is further adjustable by the microcontroller; wherein the microcontroller in response to an external control signal played by an user outputs a PWM signal to control a time length of conduction period of the first switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the low level illumination mode.

26. The life-style two-level LED security light according to claim 23, wherein when the life-style two-level LED security light is in the high level illumination mode, an illumination of the high level illumination mode is further adjustable by the microcontroller; wherein the microcontroller in response to an external control signal played by an user outputs at least a PWM signal to control a time length of conduction period of at least the second switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing the illumination of the high level illumination mode.

27. The life-style two-level LED security light according to claim 23, wherein when the life-style two-level LED security light is in the high level illumination mode, an illumination of the high level illumination mode is further adjustable by the microcontroller; wherein the microcontroller in response to an external control signal played by an user outputs PWM signals to control time lengths of conduction period of both the first switching device and the second switching device in each duty cycle such that average electric currents proportional to the time lengths of the conduction period are delivered to the light: emitting unit for performing the illumination of the high level illumination mode.

28. The life-style two-level LED security light according to claim 27, wherein when the life-style two-level LED security light is in the high level illumination mode, the light intensity of the illumination is further adjustable by the microcontroller, wherein the microcontroller in response to the external control signal outputs PWM signals to control time lengths of conduction period of both the first switching device and the second switching device varying with the same pace in an adequate range for adjusting the light intensity of the high level illumination mode.

29. The life-style two-level LED security light according to claim 27, wherein when the life-style two-level LED security light is in the high level illumination mode, the light color temperature of the illumination is further adjustable by the microcontroller, wherein the microcontroller in response to the external control signal outputs PWM signals to control time lengths of conduction period of the first switching

device and the second switching device varying reversely in an adequate range such that controlling the light intensity of the first set of N number LEDs with the low color temperature and the light intensity of the second set of M number LEDs with the high color temperature varying simultaneously but reversely to produce a variable mingled color temperature through a light diffuser in such a manner for adjusting the light color temperature of the high level illumination mode.

30. The life-style two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are both in conduction state, the light intensity of the N number LEDs and the the intensity of the M number LEDs are respectively adjustable, wherein the microcontroller in response to an external control signal played by an user outputs a first PWM signal to control a conduction rate of the first switching device and a second PWM signal to control the conduction rate of the second switching device with an arrangement that the conduction rate of the first switching device and the conduction rate of the second switching device are reversely adjusted with the same pace such that the total power level transmitted to the N number LEDs and the M number LEDs is maintained at a constant level while a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs thru a light diffuser is proportionately adjusted according to the external control signal to perform a color temperature tuning mode.

31. The life-style two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are both in conduction state, the light intensity of the N number LEDs and the light intensity of the M number LEDs are respectively adjustable, wherein the microcontroller in response to an external control signal played by an user outputs a first PWM signal to control a conduction rate of the first switching device and a second PWM signal to control the conduction rate of the second switching device with an arrangement that the conduction rate of the first switching device and the conduction rate of the second switching device are unidirectionally and proportionally adjusted with the same pace such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs thru a light diffuser is maintained at a constant level while the light intensity of the light-emitting unit is being proportionately adjusted according to the external control signal to perform a dimming mode.

32. The life-style two-level LED security according to claim **23**, wherein when the N number LEDs and the M number LEDs are in conduction state, the light intensity and the light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the microcontroller in response to an external control signal played by an user outputs a second PWM signal to control a conduction rate of the second switching device such that the M number LEDs with the high color temperature are dimmed according to the external control signal, wherein the microcontroller manages to output a first PWM signal to control a conduction state of the first switching device such that the N number LEDs with the low color temperature operates a constant power while the M number LEDs are being dimmed to create a dim to warm effect, wherein during a cycle of the dimming and color temperature tuning control mode, the light intensity and the light color temperature of the light-emitting unit are jointly determined by the external control signal.

33. The life-style two-level LED security according to claim **32**, wherein when the M number LEDs are dimmed to a cutoff state, the microcontroller operates to change the first PWM signal to continuously reduce the conduction rate of the first switching device such that the light intensity continues to decrease with the low color temperature.

34. The life-style two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are in conduction state, the light intensity and the light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the microcontroller in response to an external control signal outputs a first PWM signal to control a conduction rate of the first switching device and a second PWM signal to control the conduction rate of the second switching device, wherein the first PWM signal and the second PWM signal are configured to operate with an arrangement that the M number LEDs and the N number LEDs are respectively dimmed in such a way that the M number LEDs leads the N number LEDs in reaching a turn off state in performing the dimming and color temperature tuning control mode such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs continues to change to a warmer illumination along with a continuous reduction of light intensity to create a dim to warm effect according to the external control signal, wherein during a cycle of the dimming and color temperature turning control mode, the light intensity and the mingled color temperature of the light-emitting unit are jointly determined by the external control signal.

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EXHIBIT F

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Chen

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(54) **TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR**

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(Continued)

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CPC ***H02J 7/35*** (2013.01); ***F21S 9/03*** (2013.01); ***F21V 17/02*** (2013.01); ***G08B 5/36*** (2013.01); ***G08B 13/1895*** (2013.01); ***G08B 15/00*** (2013.01); ***G08B 15/002*** (2013.01); ***H05B 33/083*** (2013.01); ***H05B 33/0809*** (2013.01); ***H05B 33/0815*** (2013.01); ***H05B 33/0818*** (2013.01); ***H05B 33/0824*** (2013.01);
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USPC 315/149, 152, 154, 307, 308, 312
See application file for complete search history.

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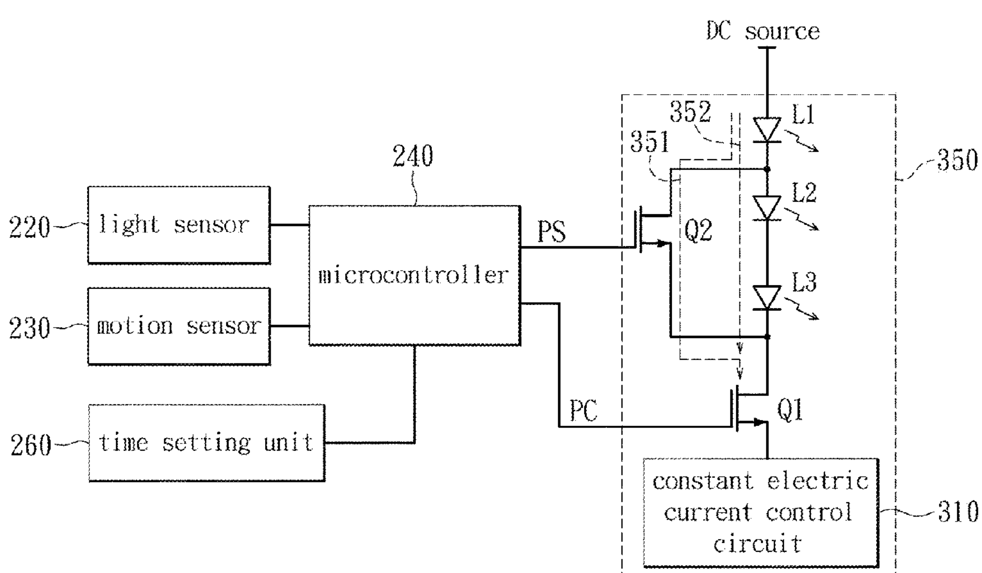
(57) **ABSTRACT**

A lifestyle LED security light including a light-emitting unit configured with two sets of LED loads respectively emitting different color temperature lights is disclosed. At dusk the light-emitting unit is automatically turned on for a first level illumination with a low color temperature light featuring an aesthetic night view with the motion sensor being deactivated for a time duration, and then the light emitting unit is changed to a second level illumination and at the same time the motion sensor is activated, wherein when the motion sensor detects a motion intrusion, the light-emitting unit is instantly switched to perform a third level illumination with a a high light intensity and a high color temperature light. The color temperatures of the first level illumination and the third level illumination are respectively adjustable by simultaneously and reversely adjusting the electric powers respectively allocated to the two sets of LED loads.

89 Claims, 18 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/785,658, filed on Oct. 17, 2017, now Pat. No. 10,326,301, which is a continuation of application No. 15/375,777, filed on Dec. 12, 2016, now Pat. No. 9,826,590, which is a continuation of application No. 14/836,000, filed on Aug. 26, 2015, now Pat. No. 9,622,325, which is a division of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

(51) **Int. Cl.**

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H05B 39/04	(2006.01)
F21S 9/03	(2006.01)
F21V 17/02	(2006.01)
G08B 5/36	(2006.01)
G08B 13/189	(2006.01)
F21Y 115/10	(2016.01)
G08B 13/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H05B 33/0827*** (2013.01); ***H05B 33/0854*** (2013.01); ***H05B 33/0872*** (2013.01); ***H05B 37/02*** (2013.01); ***H05B 37/0218*** (2013.01); ***H05B 37/0227*** (2013.01); ***H05B 37/0281*** (2013.01); ***H05B 39/042*** (2013.01); ***H05B 39/044*** (2013.01); *F21Y 2115/10* (2016.08); *G08B 13/00* (2013.01); *G08B 13/189* (2013.01); *Y02B 20/40* (2013.01); *Y02B 20/44* (2013.01); *Y02B 20/46* (2013.01)

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2010/0013409	A1 *	1/2010	Quek	H05B 33/0815 315/294
2010/0201267	A1 *	8/2010	Bourquin	H05B 37/0227 315/32
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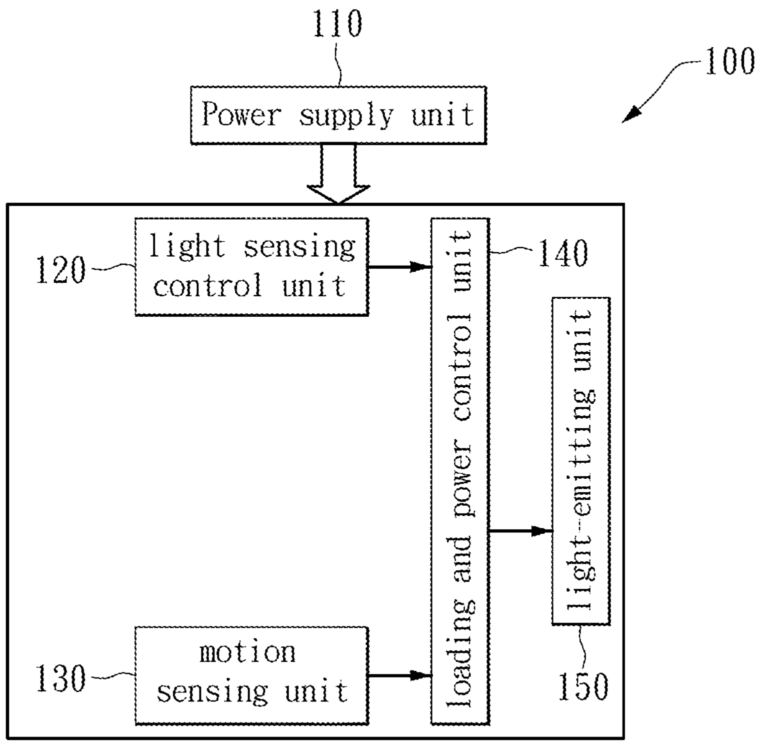
110
100
Power supply unit
120
light sensing control unit
140
loading and power control unit
light-emitting unit
130
motion sensing unit
150

FIG. 1

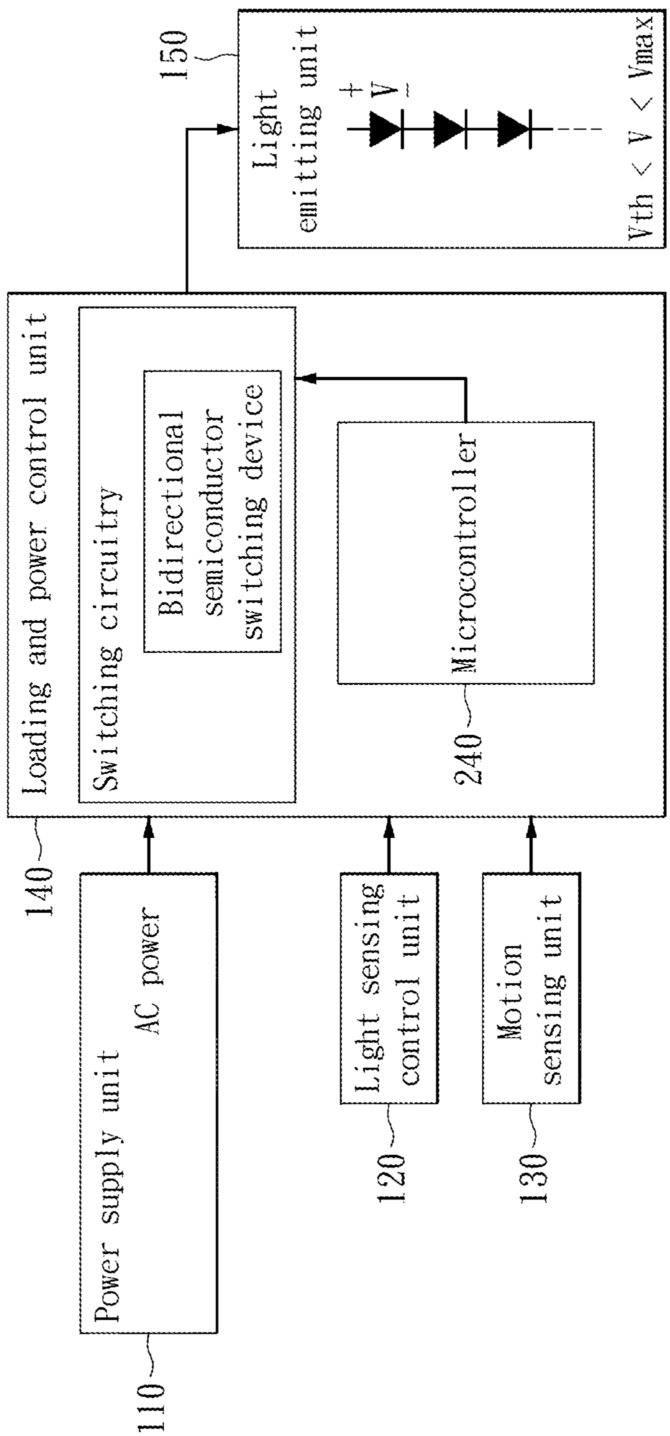
150
Light emitting unit
+ V −
Vth < V < Vmax
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
Light sensing control unit
Motion sensing unit
110
120
130

FIG. 1A

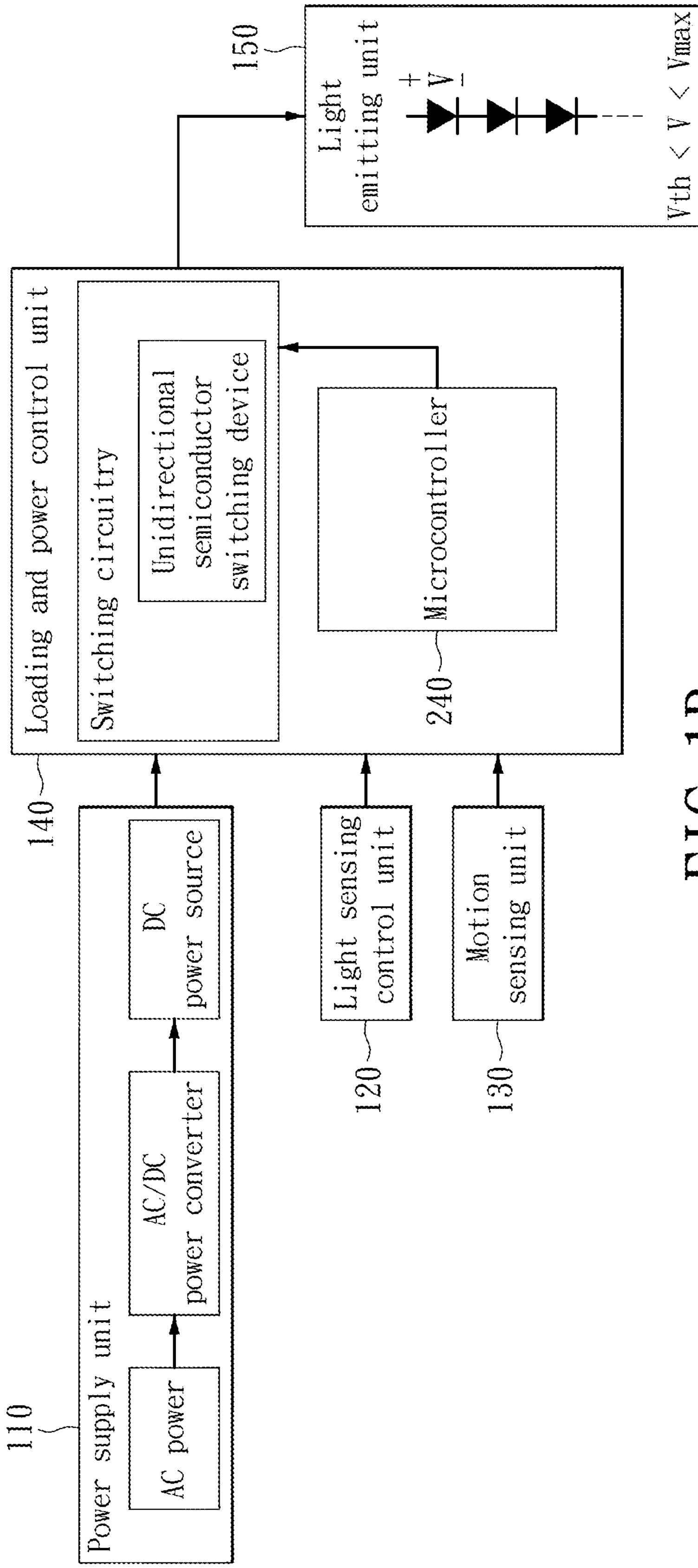
110
Power supply unit
AC power
AC/DC power converter
DC power source
140
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
120
Light sensing control unit
130
Motion sensing unit
150
Light emitting unit
+ V −
Vth < V < Vmax

FIG. 1B

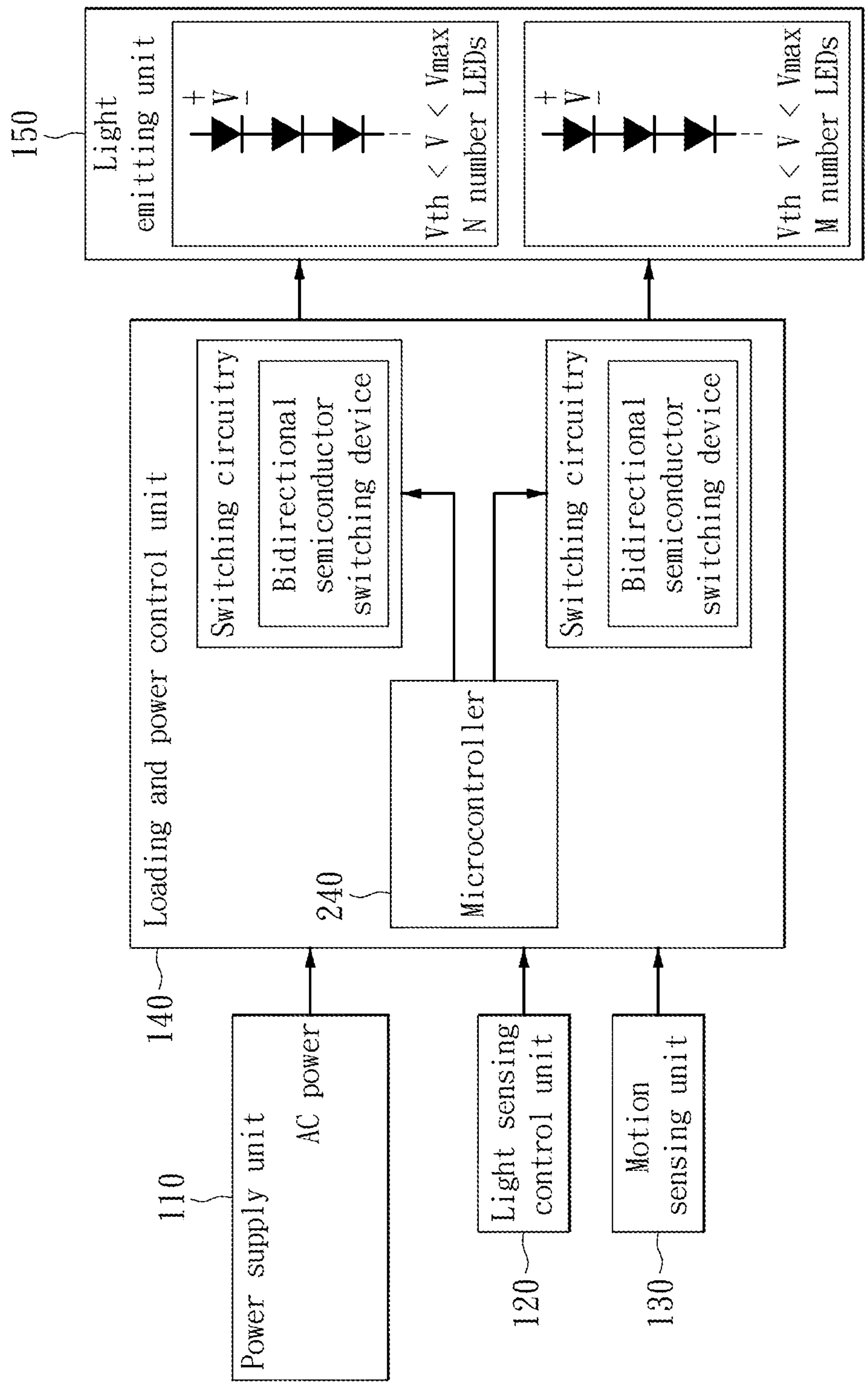
150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
140
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Switching circuitry
Bidirectional semiconductor switching device
240
Microcontroller
110
Power supply unit
AC power
120
Light sensing control unit
130
Motion sensing unit

FIG. 1C

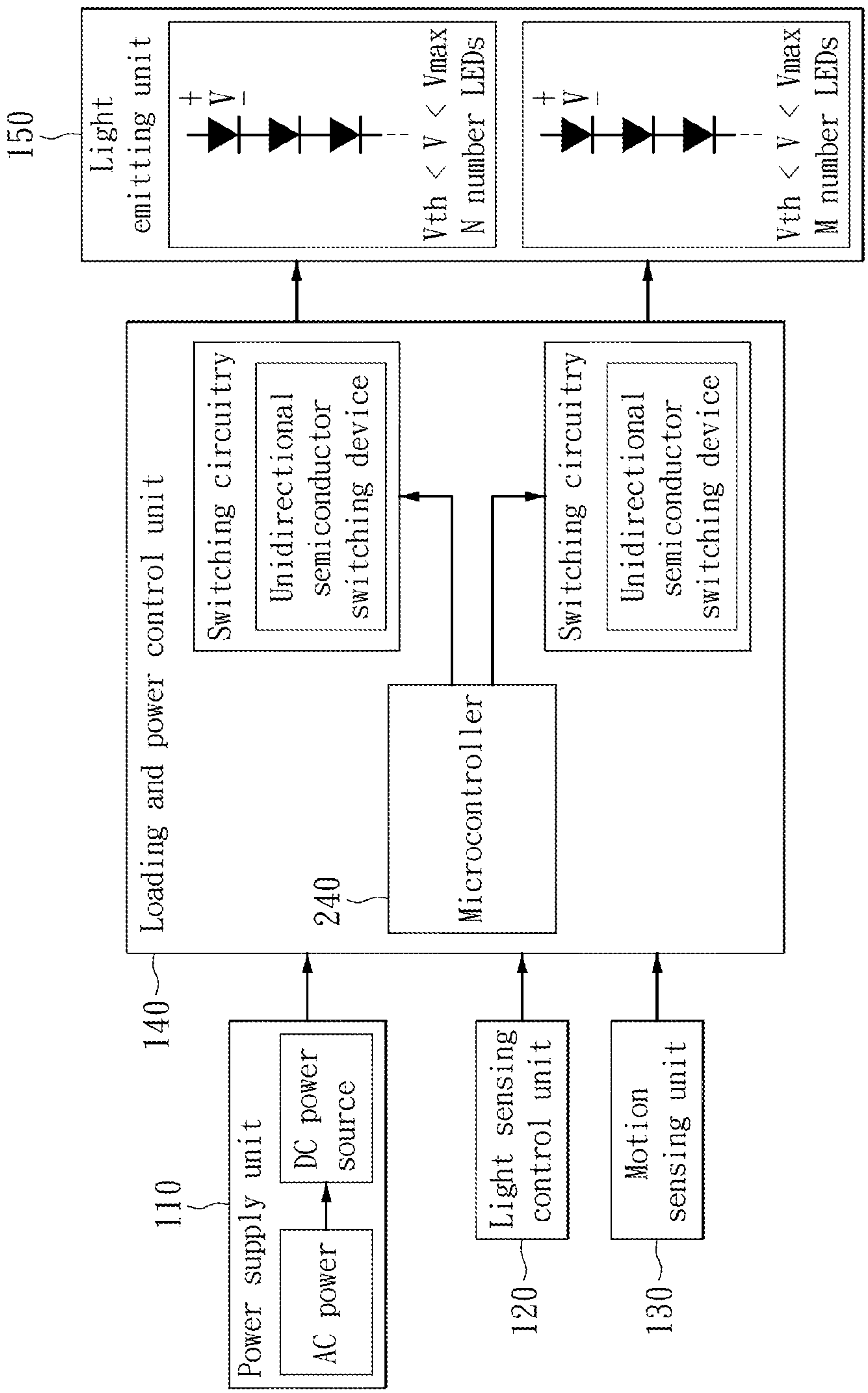
150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Switching circuitry
Unidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
DC power source
Light sensing control unit
120
Motion sensing unit
130

FIG. 1D

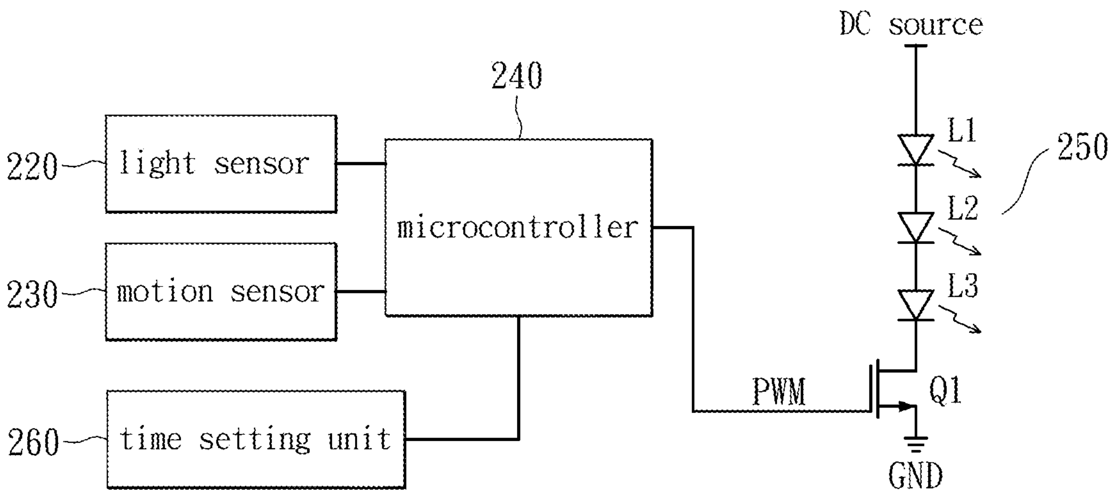
DC source
240
220
light sensor
230
motion sensor
260
time setting unit
microcontroller
L1
L2
L3
250
PWM
Q1
GND

FIG. 2A

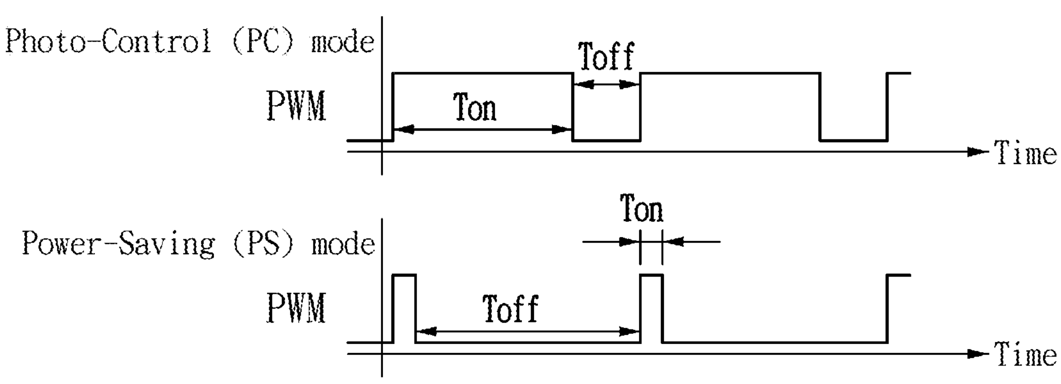
Photo-Control (PC) mode
PWM
Ton
Toff
Time
Power-Saving (PS) mode
PWM
Toff
Ton
Time

FIG. 2B

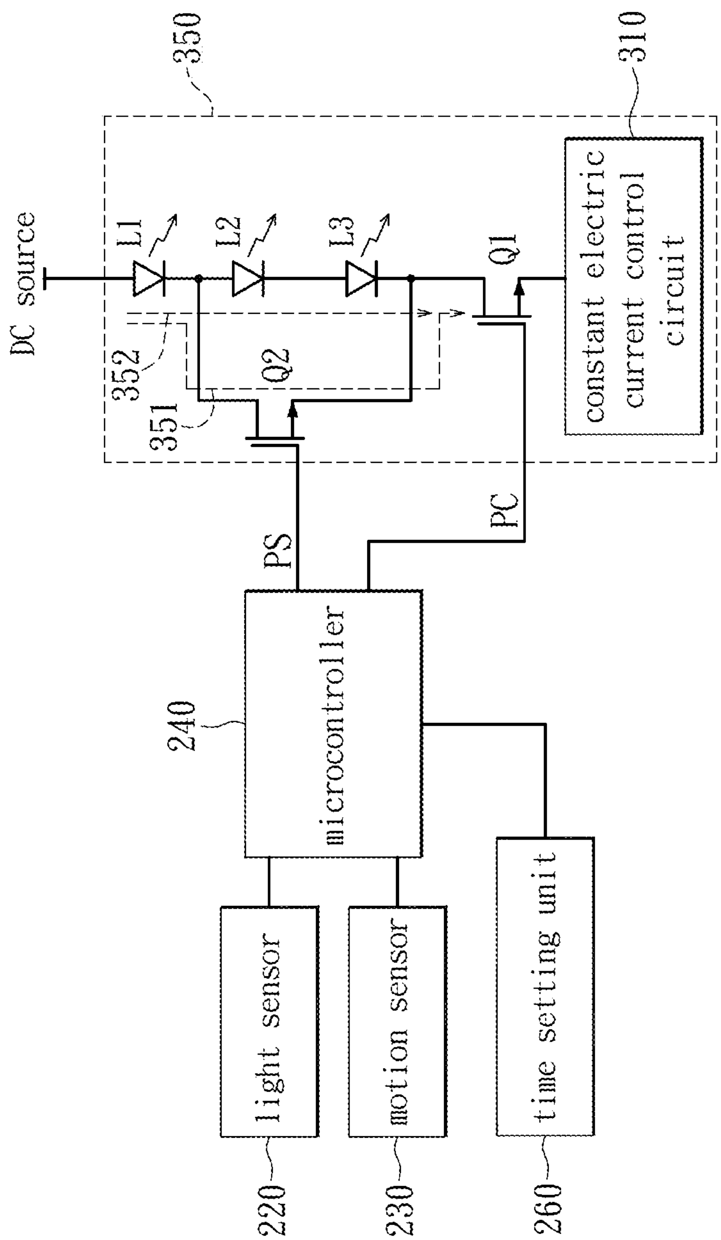
350
310
DC source
L1
L2
L3
Q1
352
351
Q2
constant electric current control circuit
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

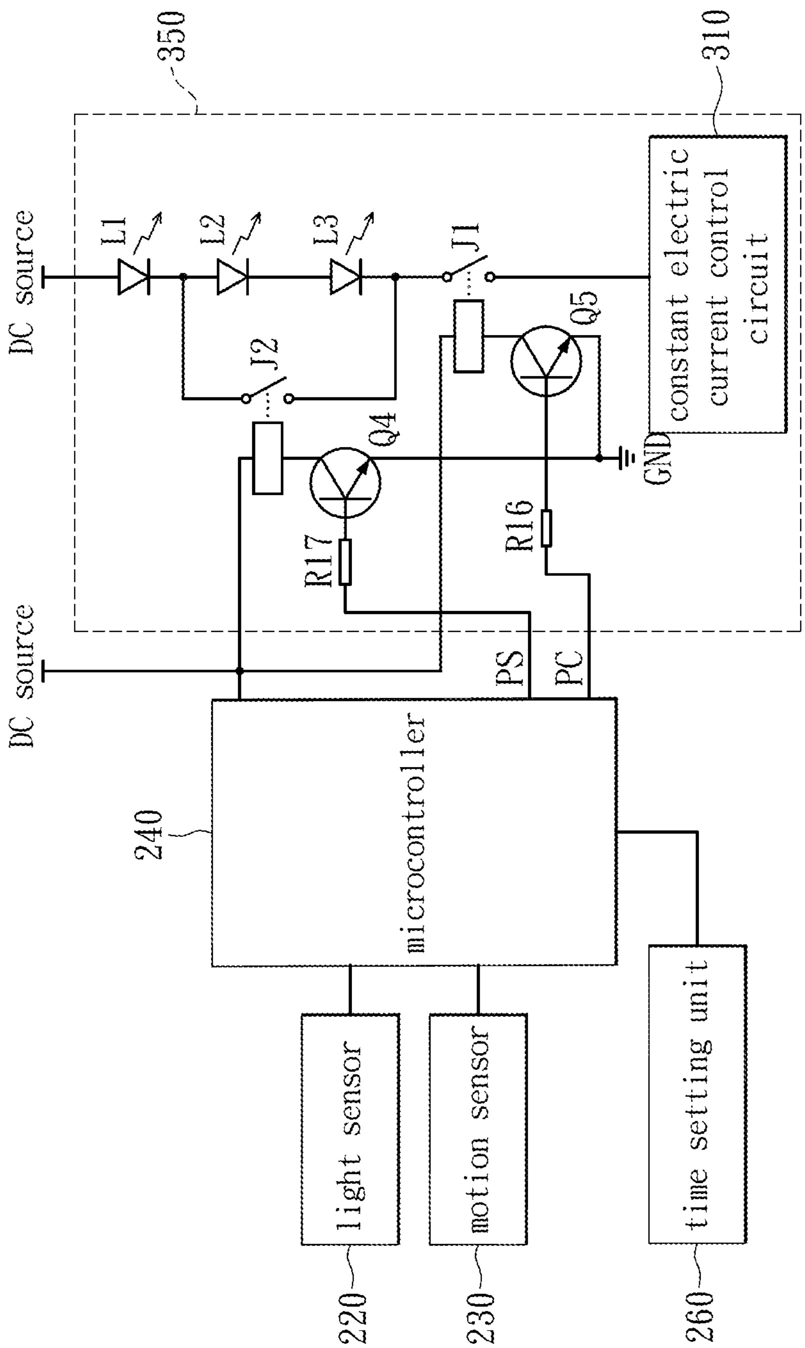
350
310
DC source
L1
L2
L3
J1
J2
Q4
Q5
GND
R16
R17
constant electric current control circuit
DC source
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

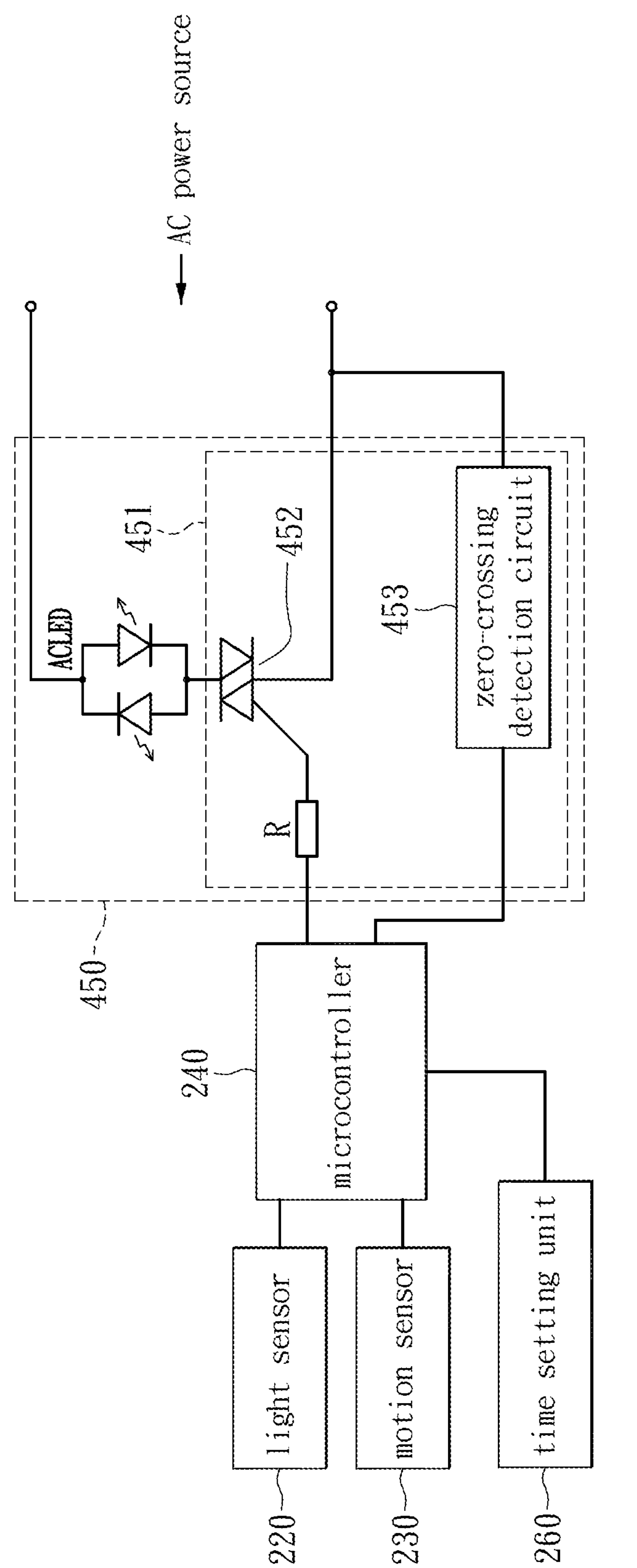
AC power source
451
452
453
ACLED
zero-crossing detection circuit
R
450
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

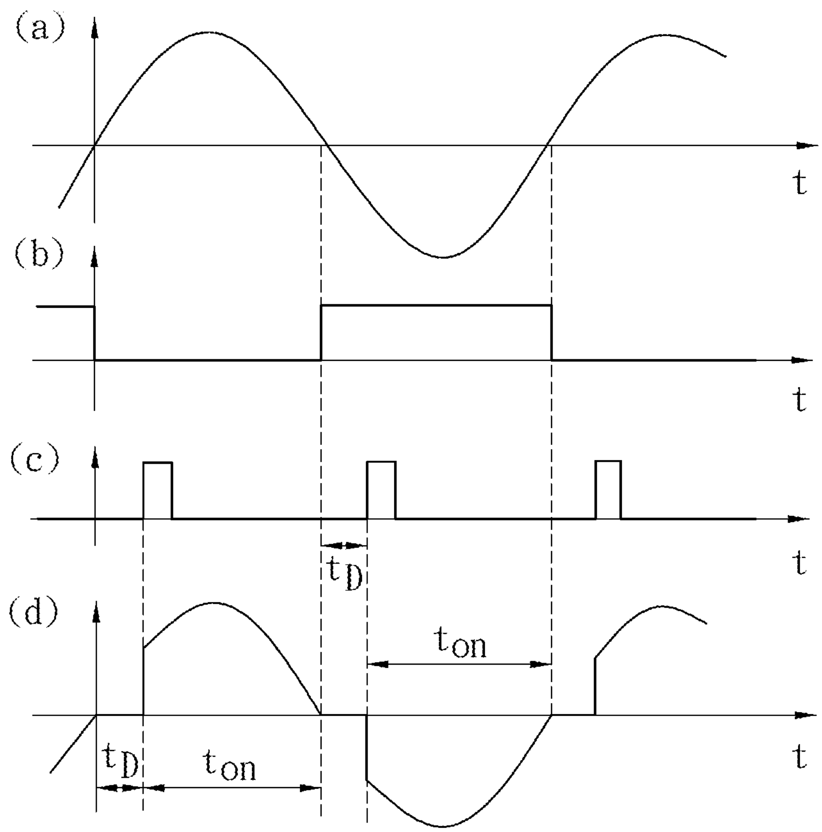

FIG. 4B

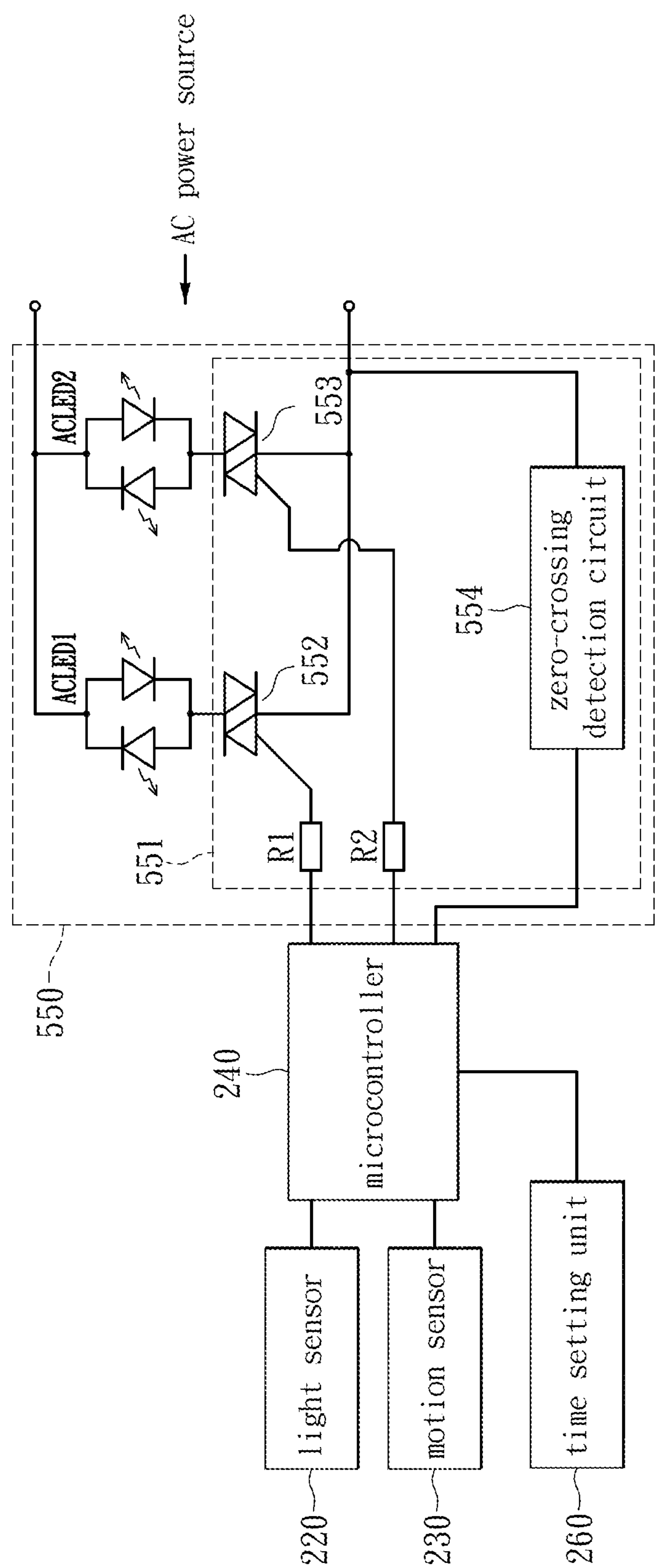
AC power source
ACLED2
ACLED1
553
552
551
550
R1
R2
554
zero-crossing detection circuit
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

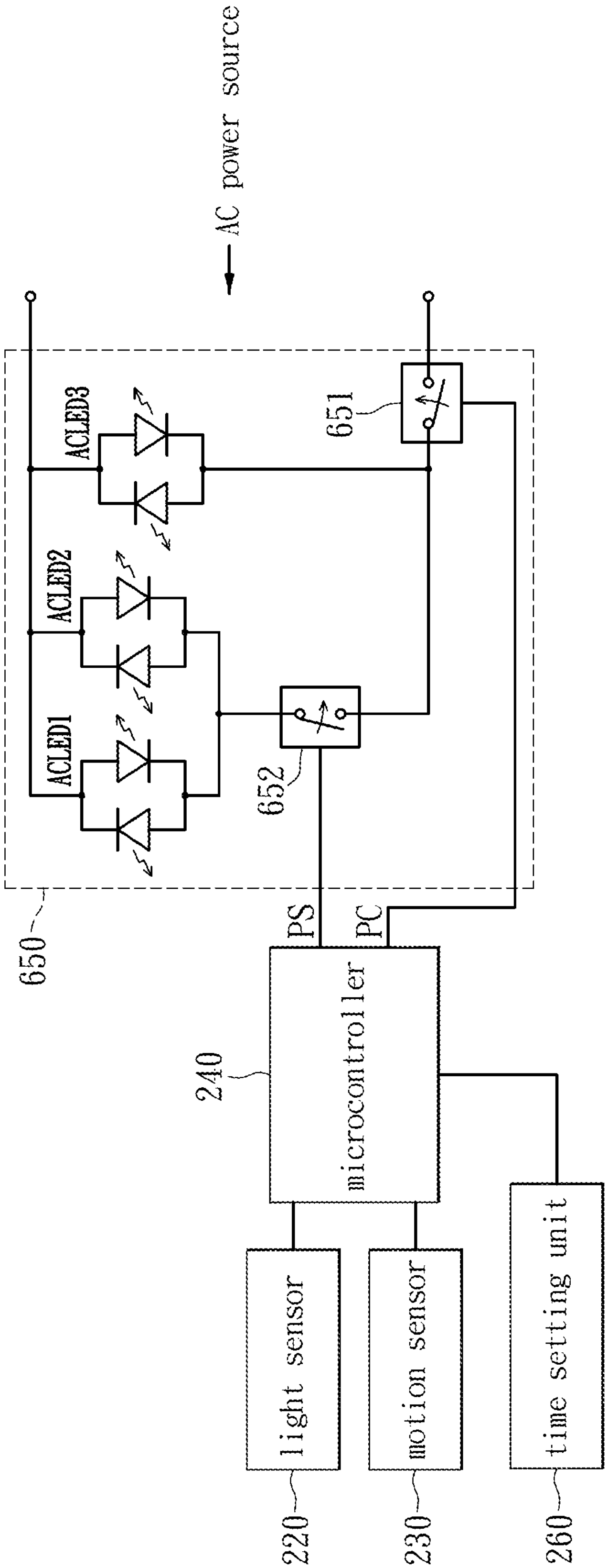
AC power source
ACLED3
ACLED2
ACLED1
651
652
650
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

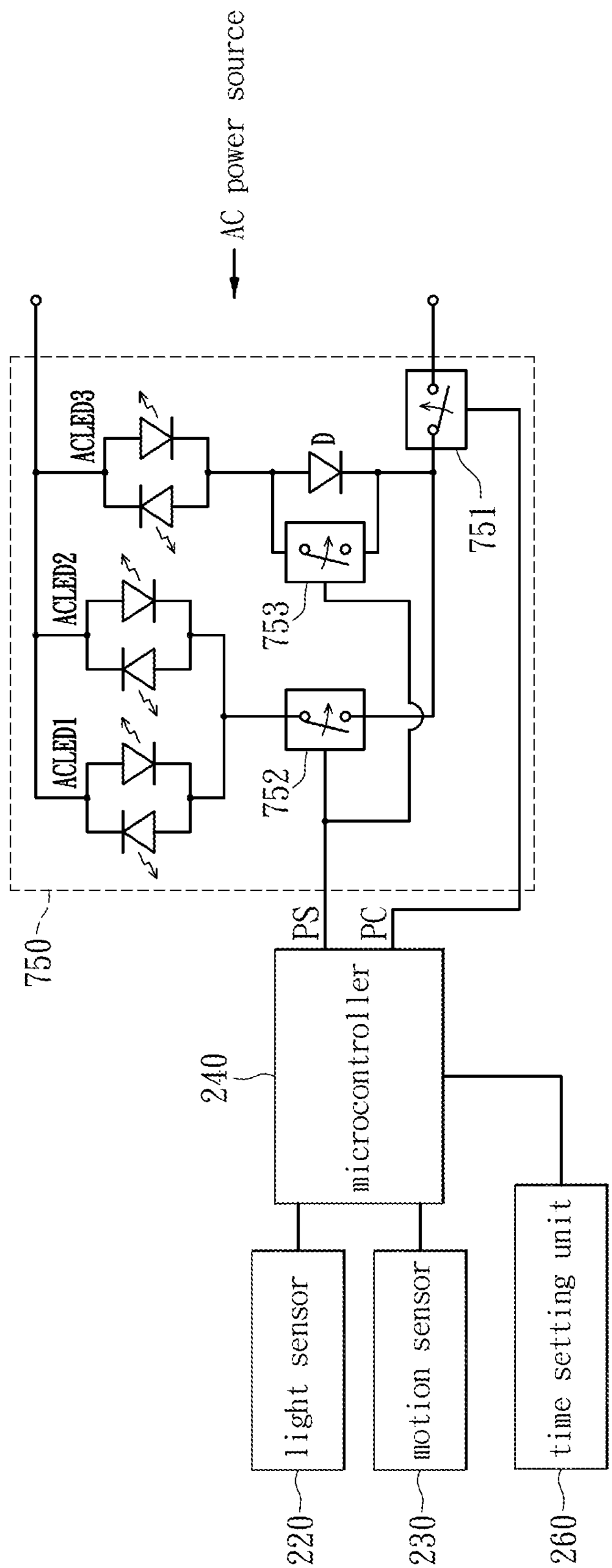
AC power source
ACLED3
ACLED2
ACLED1
D
751
753
752
750
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

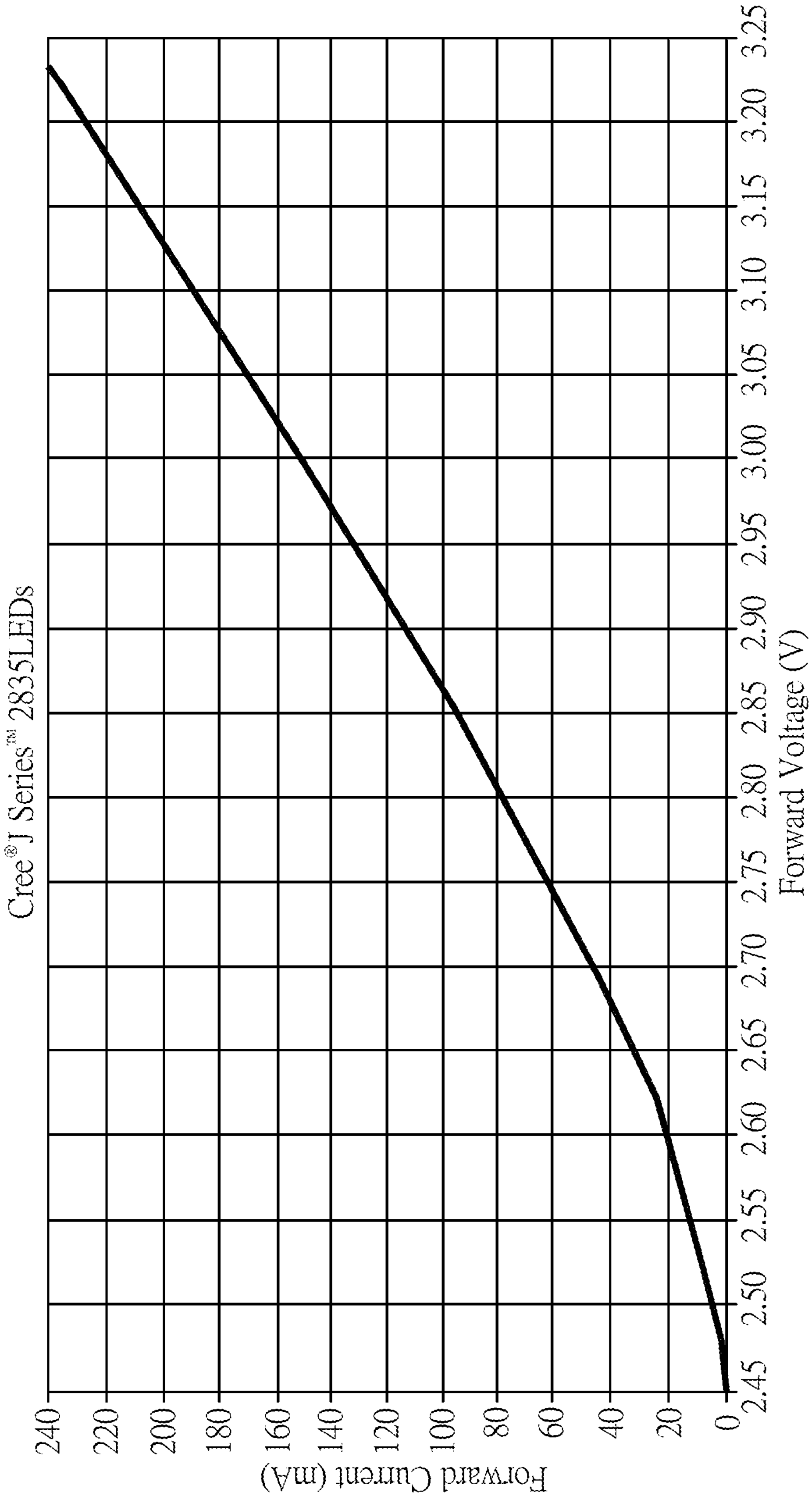
Cree® J Series™ 2835LEDs
Forward Current (mA)
240
220
200
180
160
140
120
100
80
60
40
20
0
Forward Voltage (V)
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25

FIG. 8A

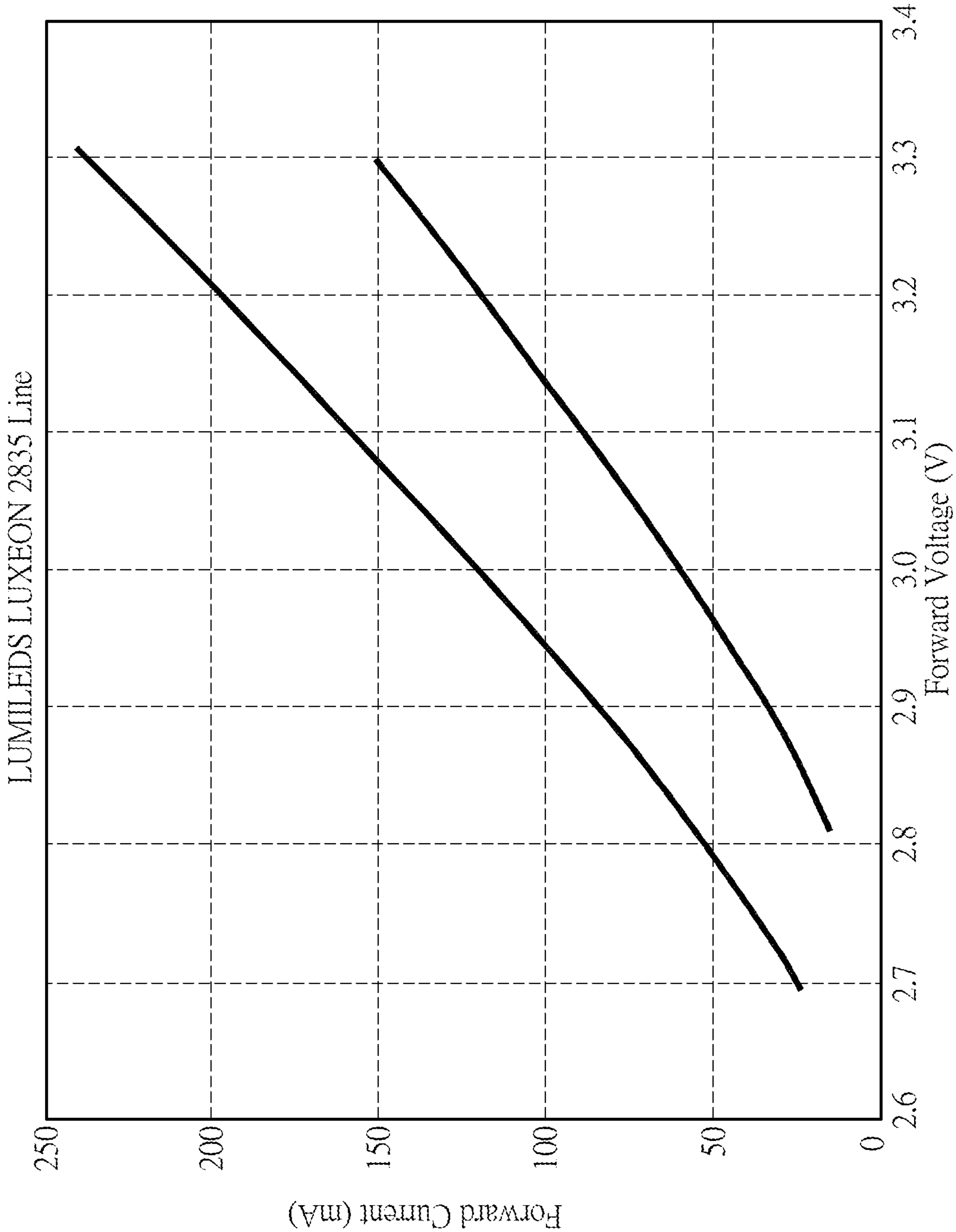
LUMILEDS LUXEON 2835 Line
Forward Current (mA)
250
200
150
100
50
0
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4

FIG. 8B

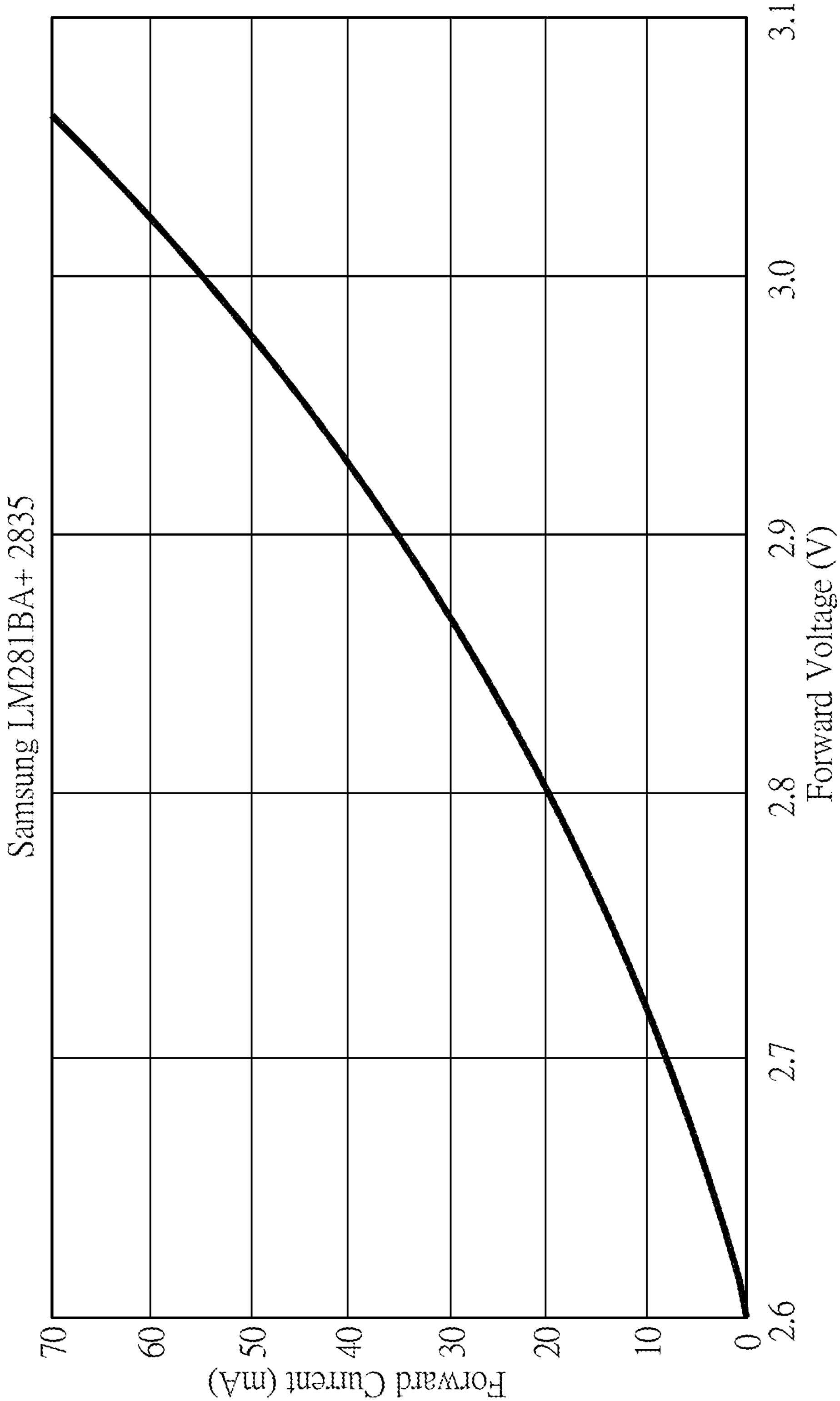
Samsung LM281BA+ 2835
Forward Current (mA)
70
60
50
40
30
20
10
0
2.6
2.7
2.8
2.9
3.0
3.1
Forward Voltage (V)

FIG. 8C

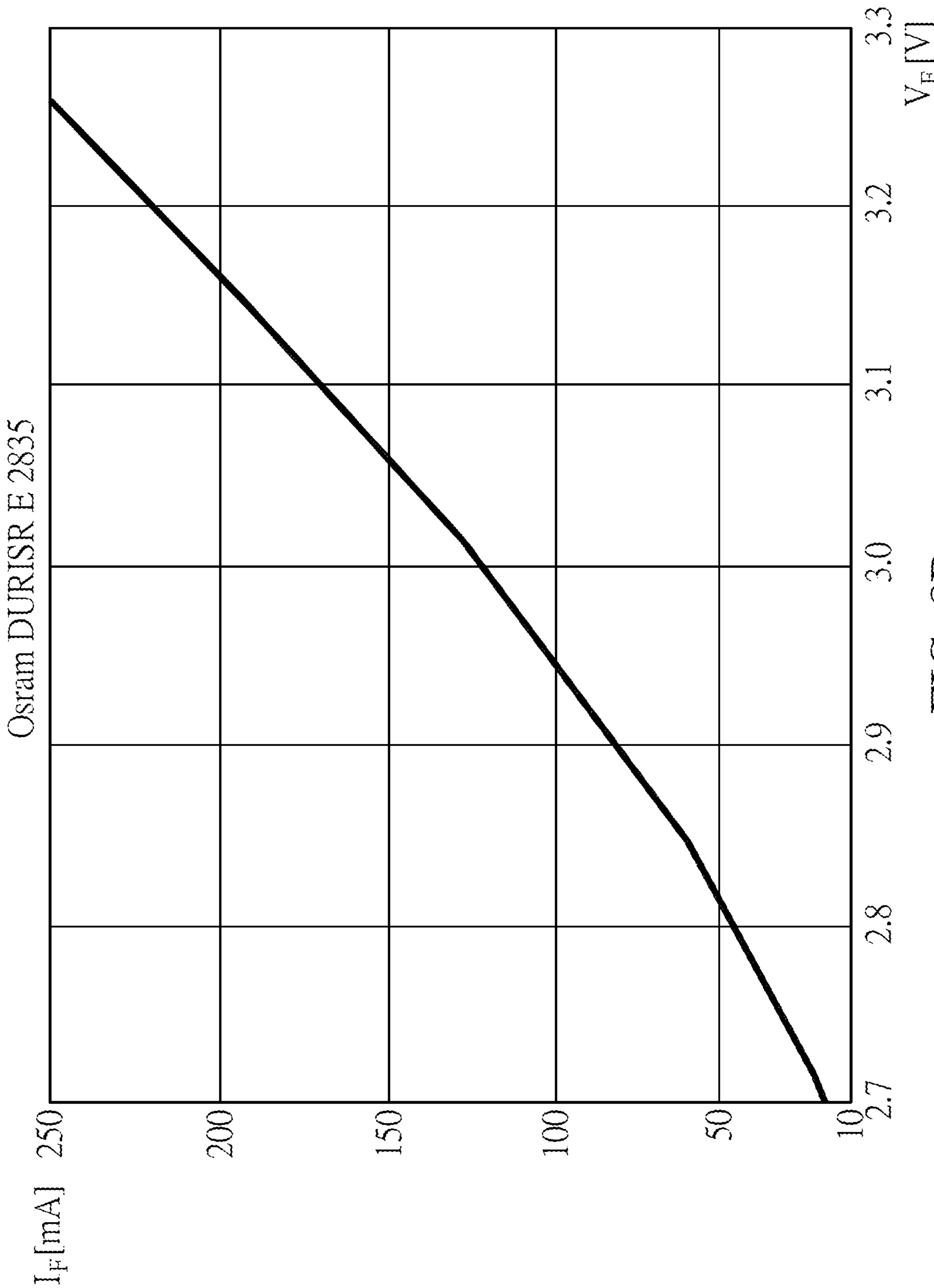
Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
2.7
2.8
2.9
3.0
3.1
3.2
3.3
V_F [V]

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation application of prior application Ser. No. 15/896,403, filed on 14 Feb. 2018, currently pending. Ser. No. 15/896,403 is a continuation application of prior application Ser. No. 15/785,658, filed on 17 Oct. 2017, currently pending. Ser. No. 15/785,658 is a continuation application of prior application Ser. No. 15/375,777 filed on 12 Dec. 2016, which issued as U.S. Pat. No. 9,826,590. U.S. Pat. No. 9,826,590 is a continuation application of prior application Ser. No. 14/836,000 filed on 26 Aug. 2015, which issued as U.S. Pat. No. 9,622,325, and which is a divisional application of Ser. No. 14/478,150, filed on 5 Sep. 2014, issued as U.S. Pat. No. 9,445,474, which is a continuation application of Ser. No. 13/222,090, filed 31 Aug. 2011, which issued as U.S. Pat. No. 8,866,392 on 21 Oct. 2014.

BACKGROUND OF THE INVENTION

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photoresistors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY OF THE INVENTION

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a phase controller and one or a plurality of parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage

ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto-turnoff at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediate switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an AC LED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the AC LED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **1**C is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a AC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises bidirectional semiconductor switching devices for controlling an average electric power to be delivered to the AC LED.

FIG. **1**D is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises unidirectional semiconductor switching devices for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C and **8**D schematically and respectively show I-V relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. A two-level LED security light (herein as the lighting apparatus) **100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs and switching components. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that the ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flow through the light-emitting unit **150**, to generate the high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein the DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a pulse width modulation (PWM) signal to the gate of transistor Q**1** to control the average electric current. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{off} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow the user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto. The time setting unit is a type of external control units designed to detect various external control signals and to convert the various external control signals into various message signals interpretable by the controller for setting various operating parameters of a security light including at least a time length setting for various illumination modes, a light intensity setting for various illumination modes and switching between illumination modes. The external control units may be configured with a push button, a touch sensor, a voltage divider, a power interruption detection circuitry or a wireless remote control receiver for generating message signals interpretable by the controller.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through

the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. **3**A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A and FIG. **2**A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** detects that the ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may include a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include a phase controller and one or more parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** includes a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450**

to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger the triac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<\frac{1}{2}f^{-t}{}_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(\frac{1}{2}\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t (rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (½f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D<6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**, and a phase controller **551**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLEDs and more than one bi-directional switching devices. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1**~**3** having identical luminous power as well as switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through

the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1~3** are coupled to the AC power source and the light-emitting unit **650** may generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED**3** is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ALCED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1~3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751~753** to render ACLED**1~3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs. In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

When the light source of the light emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of a voltage operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the voltage operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the threshold voltage and the maximum working voltage.

In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as the threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is the threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the threshold voltage into a corresponding time phase of AC power for lighting control, it is necessary to use the term V_{th} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC

power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V is a voltage across the LED chip, V_{th} is the threshold voltage to enable the LED chip to start emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working voltage V of each single LED chip is required to operate in a domain between a threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage V_N of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a threshold voltage of N times V_{th} ($N \times V_{th}$) and a maximum working voltage of N times V_{max} ($N \times V_{max}$) or $N \times V_{th}<V_N<N \times V_{max}$, wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V_N across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N \times V_{th}<V_N<N \times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises 4 drawings schematically and respectively showing a I-V relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage, i.e., the threshold voltage or the cut-in voltage, and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers. The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount of monetary relief was claimed with the Court in the complaint.

The present disclosure of a two-level LED security light provides a unique life-style lighting solution. The motivation of creating such life-style lighting solution has less to do with the energy saving aspect of the low level illumination mode because an LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the life-style lighting solution of the present disclosure is featured with two innovations which meaningfully improve the exquisite tastes of living in the evening, the first innovation is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination with a low color temperature which is necessary for creating a soft and aesthetic night scene for the outdoor living area (such soft and aesthetic night view is not achievable by the high level illumination however), the second innovation is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without getting lost or encountering an accident, wherein when a motion intrusion is detected by the motion sensor the security light is instantly changed to perform a high level illumination mode with a high color temperature light which offers people a high visibility of the surrounding environment when needed. For the visibility of a surrounding

environment the high color temperature light is the winner while for the creation of a soft and aesthetic night view there is no substitute for the low color temperature light. It is the innovation of the present invention to configure a life-style security light with a low color temperature LED load and a high color temperature LED load respectively activated by a photo sensor and a motion sensor to resemble the natural phenomenon of a sun light. These two innovative functions ideally implemented by the LED loads coupled with the motion sensor to increase illumination with a high visibility when people enters into the short detection area make the present invention a perfect life-style lighting solution for enjoying an exquisite taste of evening life.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A lifestyle two-level LED security light comprising:

a light-emitting unit configured with an LED load;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the LED load of the light-emitting unit includes a plurality of LEDs divided into two sets with a first set of N number LEDs and a second set of M number LEDs, wherein N and M are positive integers;

wherein the loading and power control unit includes a controller electrically coupled to the light sensing control unit, the motion sensing unit and at least two switching devices including at least a first switching device and a second switching device;

wherein the first switching device and the second switching device are electrically connected with the first set of N number LEDs and the second set of M number LEDs, wherein the first switching device and the second switching device are controlled by the controller to be conducting or cut-off to perform at least a first switching mode and a second switching mode;

wherein in the first switching mode the power supply unit drives at least the first set of N number LEDs to perform a low level illumination with a low light intensity and in the second switching mode the power supply unit drives at least the second set of M number LEDs to perform a high level illumination with a high light intensity;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to turn on the first set of N number LEDs in the light-emitting unit to generate the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than the predetermined value, the light-emitting unit is switched off;

wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to turn on at least the second set of M number LEDs to generate the high level illumination for a predetermined duration before resuming to the low level illumination; wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit, and wherein the plurality of LEDs of the first set of N number LEDs and the second set of M number LEDs in conjunction with a power level setting of the power supply unit are respectively designed with a configuration of in series and/or in parallel connections of LEDs such that an electric current passing through each LED of the light-emitting unit remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED; wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage to LED construction.

2. The lifestyle two-level LED security light according to claim **1**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit continues to turn on the first set of N number LEDs.

3. The lifestyle two-level LED security light according to claim **1**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit manages to turn off the first set of N number LEDs.

4. The lifestyle two-level LED security light according to claim **1**, wherein a total wattage of the M number LEDs is greater than a total wattage of the N number LEDs.

5. The lifestyle two-level LED security light according to claim **1**, wherein a total wattage of the M number LEDs is equal to a total wattage of the N number LEDs.

6. The lifestyle two-level LED security light according to claim **1**, wherein the power supply unit outputs a DC power for operating the two-level LED security light, wherein the first set of N number LEDs and the second set of M number LEDs are connected in series, wherein a constant current control circuit is connected in series with the light-emitting unit such that an electric current level remains stable in light of a drastic change of lighting load between driving the N number LEDs for generating the low level illumination and driving at least the M number LEDs for generating the high level illumination.

7. The lifestyle two-level LED security light according to claim **6**, wherein when the two-level LED security is operated to generate the low level illumination, the low light intensity is further adjustable by the controller; wherein the first set of N number LEDs is configured to include a plurality of switching devices electrically coupled to the first set of N number LEDs and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the N number LEDs through bypassing unwanted LEDs in the N number LEDs respectively with the associated switching device(s) according to an external control signal played by a user or according to a value of a voltage divider set by the user.

8. The lifestyle two-level LED security light according to claim **6**, wherein when the two-level LED security is operated to generate the high level illumination, the high light intensity is further adjustable by the controller, wherein the second set of M number LEDs is configured to include a plurality of switching devices electrically coupled to the second set of M number LEDs and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the M number LEDs through bypassing unwanted LEDs in the M number LEDs with the associated switching device(s) according to an external control signal played by a user or according to a value of a voltage divider set by the user.

9. The lifestyle two-level LED security light according to claim **1**, wherein the power supply unit outputs at least one

DC power for operating the two-level LED security light; wherein the first set of N number LEDs and the second set of M number LEDs are connected in parallel, wherein the first switching device is electrically connected in series between the first set of N number LEDs and the power supply unit, wherein the second switching device is electrically connected in series between the second set of M number LEDs and the power supply unit.

10. The lifestyle two-level LED security light according to claim **9**, wherein when the two-level LED security light is operated to generate the low level illumination, the low light intensity of the low level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs a PWM signal to control a time length of conduction period of the first switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the low level illumination mode.

11. The lifestyle two-level LED security light according to claim **9**, wherein when the two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs at least a PWM signal to control a time length of conduction period of at least the second switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the high level illumination mode.

12. The lifestyle two-level LED security light according to claim **9**, wherein when the two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs PWM signals to control time lengths of conduction periods of both the first switching device and the second switching device in each duty cycle such that average electric currents proportional to the time lengths of the conduction periods are delivered to the light-emitting unit for performing a dimming work of the high level illumination mode.

13. The lifestyle two-level LED security light according to claim **1**, wherein when each of the first set of N number LEDs and the second set of M number LEDs is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first set of N number LEDs and the second set of M number LEDs is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

14. The lifestyle two-level LED security light according to claim **13**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the first set of N number LEDs and the second set of M number LEDs are required to operate with respective operating voltages V_N and V_M confined in domains expressed by $N_S\times2.5$ volts $<V_N<N_S\times3.5$ volts and $M_S\times2.5$ volts $<V_M<M_S\times3.5$ volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first set of N number LEDs and the second set of M number LEDs, wherein $N_S\leq N$ and $M_S\leq M$.

15. A lifestyle two-level LED security light comprising:

a light-emitting unit configured with an LED load;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the LED load of the light-emitting unit includes a plurality of LEDs divided into two sets with a first set of N number LEDs and a second set of M number LEDs, wherein N and M are positive integers; wherein the first set of N number LEDs and the second set of M number LEDs are covered by a light diffuser to create a diffused light;

wherein the loading and power control unit includes a controller electrically coupled to the light sensing control unit, the motion sensing unit and at least two switching devices including a first switching device and a second switching device;

wherein the first switching device and the second switching device are connected with the first set of N number LEDs and the second set of M number LEDs;

wherein the two switching devices are controlled by the controller to be respectively conducting or cut-off to perform at least a first switching mode and a second switching mode;

wherein in the first switching mode at least the first set of N number LEDs is turned on to perform a low level illumination with a low light intensity and in the second switching mode at least the second set of M number LEDs is turned on to perform a high level illumination with a high light intensity;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to turn on at least the first set of N number LEDs in the light-emitting unit to generate the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than the predetermined value, the LED load is switched off;

wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to turn on at least the second set of M number LEDs in the light-emitting unit to generate the high level illumination for a predetermined duration; and

wherein the N number LEDs emit light with a low color temperature to produce a soft and warm light to feature an aesthetic night view around the living area both for indoor and outdoor need while at the same time create a navigation capacity similar to a light house to help people move to a destination without getting lost or encountering an accident, wherein the M number LEDs emit light with a high color temperature to produce a much brighter light with a dual effect of security alert by means of creating drastic changes in both light intensity from low to high and light color temperature from warm to cool upon detecting a motion intrusion, wherein the high level illumination with the high color temperature enables people to have a high visibility of the surrounding environment when needed; and wherein the plurality of LEDs of the first set of N number LEDs and the second set of M number LEDs in conjunction with a power level setting of the power supply unit are respectively designed with a configu-

ration of in series and/or in parallel connections of LEDs such that an electric current passing through each LED of the light-emitting unit remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED; wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage to LED construction.

16. The lifestyle two-level LED security light according to claim **15**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit continues to turn on the first set of N number LEDs.

17. The lifestyle two-level LED security light according to claim **15**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit manages to turn off the first set of N number LEDs.

18. The lifestyle two-level LED security light according to claim **15**, wherein a total wattage of the M number LEDs is greater than a total wattage of the N number LEDs.

19. The lifestyle two-level LED security light according to claim **15**, wherein a total wattage of the M number LEDs is equal to a total wattage of the N number LEDs.

20. The lifestyle two-level LED security light according to claim **15**, wherein the power supply unit outputs a DC power for operating the lifestyle two-level LED security light, wherein the first set of N number LEDs and the second set of M number LEDs are connected in series, wherein a constant current control circuit is connected in series with the light-emitting unit such that an electric current level remains stable in light of a drastic change of lighting load between driving the N number LEDs for generating the low level illumination and driving at least the M number LEDs for generating the high level illumination.

21. The lifestyle two-level LED security light according to claim **20**, wherein when the lifestyle two-level LED security is operated to generate the low level illumination, the low light intensity is further adjustable by the controller; wherein the first set of N number LEDs is configured to include a plurality of switching devices electrically coupled to the first set of N number LEDs and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the N number LEDs through bypassing unwanted LEDs in the N number LEDs with the associated switching device(s) according to an external control signal played by a user or according to a value of a voltage divider set by the user.

22. The lifestyle two-level LED security light according to claim **20**, wherein when the two-level LED security is operated to generate the high level illumination, the high light intensity is further adjustable by the controller, wherein the second set of M number LEDs is configured to include a plurality of switching devices electrically coupled to the second set of M number LEDs and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the M number LEDs through bypassing unwanted LEDs in the M number LEDs with the associated switching device(s) according to an external control signal played by a user or according to a value of a voltage divider set by the user.

23. The lifestyle two-level LED security light according to claim **15**, wherein the power supply unit outputs at least one DC power for operating the two-level LED security light; wherein the first set of N number LEDs and the second set of M number LEDs are connected in parallel, wherein the first switching device is electrically connected in series between the first set of N number LEDs and the power supply unit, wherein the second switching device is electrically connected in series between the second set of M number LEDs and the power supply unit.

24. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the low level illumination, the low light intensity of the low level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs at least a PWM signal to control a time length of conduction period of at least the first switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the low level illumination.

25. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs at least a PWM signal to control a time length of conduction period of at least the second switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the high level illumination.

26. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs PWM signals to control time lengths of conduction period of both the first switching device and the second switching device in each duty cycle such that average electric currents proportional to the time lengths of the conduction period are delivered to the light-emitting unit for performing a dimming work of the high level illumination.

27. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller, wherein the controller in response to the external control signal outputs PWM signals to control time lengths of conduction periods of both the first switching device and the second switching device varying with the same pace in a range for adjusting the high light intensity of the high level illumination.

28. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the low level illumination, a light color temperature of the low level illumination is further adjustable by the controller, wherein the controller in response to the external control signal outputs PWM signals to control time lengths of conduction periods of the first switching device and the second switching device to vary in a reverse manner such that a light intensity of the first set of N number LEDs with the low color temperature and a light intensity of the second set of M number LEDs with the high color temperature are reversely adjusted with the same pace to produce a variable mingled color temperature thru a light diffuser for performing a color temperature tuning of the low level illumination.

29. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the high level illumination, a light color temperature of the high level illumination is further adjustable by the controller, wherein the controller in response to the external control signal outputs PWM signals to control time lengths of conduction periods of the first switching device and the second switching device to vary in a reverse manner such that a light intensity of the first set of N number LEDs with the low color temperature and a light intensity of the second set of M number LEDs with the high color temperature are reversely adjusted with the same pace to produce a variable mingled color temperature thru a light diffuser for performing a color temperature tuning of the high level illumination.

30. The lifestyle two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are both in conduction state, a light intensity of the N number LEDs and a light intensity of the M number LEDs are respectively adjustable, wherein the controller in response to an external control signal played by a user outputs a first PWM signal to control a first conduction rate of the first switching device and a second PWM signal to control a second conduction rate of the second switching device with an arrangement that the first conduction rate of the first switching device and the second conduction rate of the second switching device are reversely adjusted with the same pace such that a total electric power level transmitted to the N number LEDs and the M number LEDs is maintained at a constant level while a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs thru a light diffuser is proportionately adjusted according to the external control signal to perform a color temperature tuning mode.

31. The lifestyle two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are both in conduction state, a light intensity of the N number LEDs and a light intensity of the M number LEDs are respectively adjustable, wherein the controller in response to an external control signal played by an user outputs a first PWM signal to control a first conduction rate of the first switching device and a second PWM signal to control a second conduction rate of the second switching device with an arrangement that the first conduction rate of the first switching device and the second conduction rate of the second switching device are unidirectionally and proportionally adjusted with the same pace such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs thru a light diffuser is maintained at a constant level while a light intensity of the light-emitting unit is being proportionately adjusted according to the external control signal to perform a dimming mode.

32. The lifestyle two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are in conduction state, light intensity and light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the controller in response to an external control signal played by a user outputs a second PWM signal to control a second conduction rate of the second switching device such that the M number LEDs with the high color temperature are dimmed according to the external control signal, wherein the controller manages to output a first PWM signal to control a first conduction state of the first switching device such that the N number LEDs with the low color temperature operates a constant power while the M number LEDs are being dimmed to create a dim to warm effect, wherein during a cycle of the dimming and color temperature tuning control mode, a light intensity and a light color temperature of the light-emitting unit are jointly determined by the external control signal.

33. The lifestyle two-level LED security light according to claim **32**, wherein when the M number LEDs are dimmed to a cutoff state, the controller operates to change the first PWM signal to continuously reduce the first conduction rate of the first switching device such that the light intensity of the light-emitting unit continues to decrease with the low color temperature.

34. The lifestyle two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are in conduction state, light intensity and light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the controller in response to an external control signal outputs a first PWM signal to control a first conduction rate of the first switching device and a second PWM signal to control a second conduction rate of the second switching device, wherein the first PWM signal and the second PWM signal are configured to operate with an arrangement that the M number LEDs and the N number LEDs are respectively dimmed in such a way that the M number LEDs leads the N number LEDs in reaching a turned off state in performing the dimming and color temperature tuning control mode such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs continues to change to a warmer illumination along with a continuous reduction of light intensity to create a dim to warm effect according to the external control signal, wherein during a cycle of the dimming and color temperature turning control mode, a light intensity and a light color temperature of the light-emitting unit are jointly determined by the external control signal.

35. The lifestyle two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are in conduction state, a light intensity and a light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the controller in response to an external control signal outputs a first PWM signal to control a first conduction rate of the first switching device and a second PWM signal to control a second conduction rate of the second switching device, wherein the first PWM signal and the second PWM signal are configured to operate with an arrangement that the M number LEDs and the N number LEDs are respectively dimmed in such a way that the M number LEDs leads the N number LEDs in reaching a turned off state; wherein in order to accelerate color temperature tuning pace along with a continuous reduction of light intensity, the first PWM signal initially manages to increase the conduction rate of the first switching device with a pace slower than the reduction pace of the conduction rate of the second switching device such that a mingled color temperature continues to change to a warmer illumination at a faster pace to perform a faster dim to warm process, wherein when a dim to warm process ceases at a time point when the M number LEDs reaches a turned off state is an inflection time point, the first PWM signal to reversely manage to decrease the conduction rate of the first switching device till the N number LEDs reaching the turned off state in performing the dimming and color temperature tuning control mode such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs continues to change to a warmer illumination along

with a continuous reduction of light intensity to create a dim to warm effect according to the external control signal, wherein during a cycle of the dimming and color temperature turning control mode, a light intensity and a light color temperature of the light-emitting unit are jointly determined by the external control signal.

36. The lifestyle two-level LED security light according to claim **15**, wherein when each of the first set of N number LEDs and the second set of M number LEDs is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first set of N number LEDs and the second set of the M number LEDs is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

37. The lifestyle two-level LED security light according to claim **36**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<3.5$ volts and the first set of N number LEDs and the second set of M number LEDs are required to operate with respective operating voltages V_N and V_M confined in domains expressed by $N_S\times2.5$ volts $<V_N<N_S\times3.5$ volts and $M_S\times2.5$ volts $<V_M<M_S\times3.5$ volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first set of N number LEDs and the second set of M number LEDs, wherein $N_S\leq N$ and $M_S\leq M$.

38. A two-level LED security light comprising:
a light-emitting unit;
a loading and power control unit;
a light sensing control unit;
a power supply unit; and
at least one external control unit;
wherein the light-emitting unit comprises a plurality of LEDs divided into two sets of LEDs with a first set of N number LEDs emitting light with a low color temperature and a second set of M number LEDs emitting light with a high color temperature, wherein N and M are positive integers; wherein the first set of N number LEDs and the second set of M number LEDs are covered by a light diffuser to create a diffused light;
wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled to the light sensing control unit, the switching circuitry and the at least one external control unit;
wherein the switching circuitry is electrically coupled between at least one power source of the power supply unit and the light-emitting unit;
wherein the switching circuitry is controlled by the controller to perform at least respectively a first switching mode and a second switching mode according to signals respectively received from the light sensing control unit and the at least one external control unit;
wherein in the first switching mode at least the first set of the light-emitting unit is turned on to perform a first illumination mode and in the second switching mode at least the second set of the light-emitting unit is turned on to perform a second illumination mode;
wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit manages to perform at least one of the first illumination mode and the second illumination mode;
wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to turn off all the LEDs in the light-emitting unit;
wherein the at least one external control unit is electrically coupled to the controller for adjusting at least one operating parameter of a light intensity of the first illumination mode or a light intensity of the second illumination mode or for switching from the first illumination mode to the second illumination mode; and
wherein the N number LEDs of the first set of the light-emitting unit and the M number LEDs of the second set of the light-emitting unit are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with a power level setting of the power supply unit an electric current passing through each LED of the M number LEDs and each LED of the N number LEDs remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

39. The two-level LED security light according to claim **38**, wherein when each of the first set of N number LEDs and the second set of M number LEDs is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first set of N number LEDs and the second set of M number LEDs is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

40. The two-level LED security light according to claim **39**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<3.5$ volts and the first set of N number LEDs and the second set of M number LEDs are required to operate with respective operating voltages V_N and V_M confined in domains expressed by $N_S\times2.5$ volts $<V_N<N_S\times3.5$ volts and $M_S\times2.5$ volts $<V_M<M_S\times3.5$ volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first set of N number LEDs and the second set of M number LEDs, wherein $N_S\leq N$ and $M_S\leq M$.

41. The two-level LED security light according to claim **38**, wherein the at least one external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the controller operates to alternately perform one of the first illumination mode and the second illumination mode; wherein the first illumination mode is a low level illumination mode with the low color temperature and the second illumination mode is a high level illumination mode with the high color temperature.

42. The two-level LED security light according to claim **38**, wherein the at least one external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal;

wherein when the short power interruption signal is detected, the controller operates to alternately perform at least one of a first illumination mode, a second illumination mode and a third illumination mode; wherein when the first illumination mode is performed, the loading and power control unit manages to turn on only the first set of the light-emitting unit, wherein when the second illumination mode is performed, the loading and power control unit manages to turn on only the second set of the light-emitting unit, wherein when the third illumination mode is performed, the loading and power control unit manages to turn on the first set of the light-emitting unit with a reduced illumination by decreasing an electric power delivered to the first set of the light-emitting unit.

43. The two-level LED security light according to claim **38**, wherein the at least one external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the controller operates to alternately perform at least one of a first illumination mode, a second illumination mode and a third illumination mode; wherein when the first illumination mode is performed, the loading and power control unit manages to turn on only the first set of the light-emitting unit to perform the low level illumination mode emitting light with the low color temperature, wherein when the second illumination mode is performed, the loading and power control unit manages to turn on only the second set of the light-emitting unit to perform the high level illumination mode emitting light with the high color temperature; wherein when the third illumination mode is performed, the loading and power control unit manages to reduce a first light intensity of the first set of the light-emitting unit and a second light intensity of the second set of the light-emitting unit respectively with the same pace such that the light-emitting unit accordingly performs a medium mingled color temperature.

44. A two-level LED security light comprising:

a light-emitting unit configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;

a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled color temperature;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

at least one external control unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically and respectively coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the at least one external control unit;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit, wherein the power source is a DC power source configured in the power supply unit;

wherein the switching circuitry comprises at least one semiconductor switching device;

wherein the first LED load and the second LED load are connected in parallel and are further respectively and electrically coupled to the switching circuitry;

wherein the controller outputs control signals to control different conduction rates of the switching circuitry for delivering different electric powers from the power source respectively to the first LED load and the second LED load of the light emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities and different mingled color temperatures for performing different illumination modes according to signals respectively received from the light sensing control unit, the motion sensing unit and the at least one external control unit;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, at least the first LED load is switched on;

wherein the controller outputs at least a first control signal to control at least a first conduction rate of the switching circuitry such that a low electric power is delivered to the light-emitting unit to perform a low level illumination mode emitting light with a low light intensity and a low mingled color temperature;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit including the first LED load and the second LED load is switched off;

wherein when a motion signal is detected by the motion sensing unit, at least the second LED load is switched on by the loading and power control unit, wherein the controller outputs at least a second control signal to control at least a second conduction rate of the switching circuitry such that a high electric power is delivered to the light-emitting unit to perform a high level illumination mode emitting light with a high light intensity and a high mingled color temperature for a predetermined time duration before switching back to the low level illumination mode;

wherein the at least one external control unit generates at least one external control signal for adjusting or selecting at least one operating parameter including the light intensity of the low level illumination mode and the mingled color temperature of the low level illumination mode, the light intensity of the high level illumination mode, the mingled color temperature of the high level illumination mode and a time length of the predetermined time duration;

wherein the LEDs of the first LED load and the LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the power source an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

45. The two-level LED security light according to claim **44**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the first LED load or the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum

of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

46. The two-level LED security light according to claim **45**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the working voltages imposed on the first LED load and the second LED load respectively represented by V_N and V_M are confined in domains expressed by N×2.5 volts $<V_N<$N×3.5 volts and M×2.5 volts $<V_M<$M×3.5 volts, wherein N and M are positive integrals denoting respective numbers of series connected LEDs in the first LED load and the second LED load.

47. The two-level LED security light according to claim **44**, wherein when the light-emitting unit is operated in the low level illumination mode, the light intensity of the first LED load and the light intensity of the second LED load are respectively adjustable to tune the mingled color temperature of the diffused light created thru the light diffuser; wherein upon receiving the at least one external control signal from the at least one external control unit the controller operates in response to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the at least one external control signal operates to control the switching circuitry to increase a first electric power delivered to the first LED load and at the same time to decrease a second electric power delivered to the second LED lighting load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the switching circuitry to decrease the first electric power delivered to the first LED lighting load and at the same time to increase the second electric power delivered to the second LED lighting load such that a sum of the first electric power and the second electric power remains unchanged and is equal to the low electric power in the low level illumination mode.

48. The two-level LED security light according to claim **44**, wherein when the light-emitting unit is operated in the high level illumination mode, the light intensity of the first LED load and the light intensity of the second LED load are respectively adjustable to tune the mingled color temperature of the diffused light created thru the light diffuser; wherein upon receiving the at least one external control signal from the at least one external control unit the controller operates in response to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the at least one external control signal operates to control the switching circuitry to increase a first electric power delivered to the first LED load and at the same time to decrease a second electric power delivered to the second LED load such that a sum of the first electric power and the second electric power remains unchanged; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the switching circuitry to decrease the first electric power delivered to the first LED load and at the same time to increase the second electric power delivered to the second LED load such that the sum of the first electric power and the second electric power remains unchanged and is equal to the high electric power in the high level illumination mode.

49. The two-level LED security light according to claim **44**, wherein the controller is programmed to operate with at least one color temperature switching scheme for selecting the mingled color temperature of the low level illumination mode or the mingled color temperature of the high level illumination mode, wherein paired combinations of different conduction rates of the switching circuitry for controlling different electric powers to be respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the at least one external control signal received and interpreted by the controller for performing a selected mingled color temperature; wherein in programming the paired combinations of different conduction rates of the switching circuitry, a first electric power delivered to the first LED load and a second electric power delivered to the second LED load are complementarily and reversely adjusted such that a total of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remain essentially unchanged.

50. The two-level LED security light according to claim **49**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for selecting a color temperature performance of the at least one color temperature tuning scheme.

51. The two-level LED security light according to claim **49**, wherein the at least one external control unit includes at least one push button or one touch pad and the at least one external control signal is a short voltage signal with a time length corresponding to a time duration of the push button or the touch pad being operated by a user, wherein upon receiving the short voltage signal the controller operates the pick and play process to alternately perform a selected mingled light color temperatire in the color temperature switching scheme according to a preset sequence.

52. The two-level LED security light according to claim **49**, wherein the at least one external control unit is a wireless remote control receiver and the at least one external control signal is a wireless signal transmitted from a mobile device.

53. The two-level LED security light according to claim **49**, wherein in tuning the mingled color temperature the controller operates to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with an arrangement that a total electric power of the light-emitting unit is kept essentially unchanged during adjusting process.

54. The two-level LED security light according to claim **49**, wherein the at least one external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the controller operates to alternately switch a selection of different mingled color temperatures according to the at least one color temperature tuning scheme preprogrammed.

55. A lifestyle LED security light comprising:

- a light-emitting unit, configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;
- a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled color temperature;
- a loading and power control unit;

a light sensing control unit;
a motion sensing unit;
a power supply unit; and
at least one external control unit;
wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically and respectively coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the at least one external control unit;
wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit, wherein the power source is a DC power source configured in the power supply unit;
wherein the switching circuitry comprises at least a first semiconductor switching device and at least a second semiconductor switching device;
wherein the first LED load and the second LED load are connected in parallel and are further respectively and electrically coupled to the first semiconductor switching device and the second semiconductor switching device;
wherein the controller outputs a first control signal to control a first conduction rate of the first semiconductor switching device for delivering a first electric power to the first LED load and simultaneously a second control signal to control a second conduction rate of the second semiconductor switching device for delivering a second electric power to the second LED load such that the light-emitting unit respectively generates illuminations of different light intensities and different mingled color temperatures for performing different illumination modes according to signals respectively received from the light sensing control unit, the motion sensing unit and the at least one external control unit;
wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on to perform a first illumination mode with the motion sensing unit being temporarily deactivated;
wherein the controller outputs at least the first control signal to control at least the first conduction rate of at least the first semiconductor switching device such that a total electric power is delivered to the light-emitting unit to perform the first illumination mode with a first level illumination characterized by a first light intensity and a first mingled color temperature for a first predetermined time duration;
wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to cutoff the total electric power delivered to the light-emitting unit and at the same time the motion sensing unit is activated;
wherein when a motion signal is detected by the motion sensing unit, the controller operates to output at least the second control signal to control at least the second conduction rate of at least the second semiconductor switching device to increase the total electric power delivered to the light-emitting unit to perform a second illumination mode with a second level illumination characterized by a second light intensity and a second mingled color temperature for a second predetermined time duration before being switched back to the turned off state, wherein the second light intensity of the second level illumination is equal to or higher than the first light intensity of the first level illumination;
wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit including the first LED load and the second LED load is switched off;
wherein the at least one external control unit is a voltage divider, a push button, a touch pad, a wireless signal receiver or a power interruption detection circuitry, generating at least one external control signal to the controller for adjusting or selecting at least one operating parameter of the light-emitting unit including the light intensity, the mingled color temperature, a time length for the first predetermined time duration or a time length for the second predetermined time duration respectively in the first illumination mode or in the second illumination mode;
wherein the LEDs of the first LED load and the LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the power source of the power supply unit an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

56. The lifestyle LED security light according to claim **55**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the first LED load or the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in sereis or sets of in parallel connected LEDs electrically connected in series.

57. The lifestyle LED security light according to claim **56**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the working voltages imposed on the first LED load and the second LED load respectively represented by V_N and V_M are confined in domains expressed by N×2.5 volts $<V_N<$N×3.5 volts and M×2.5 volts $<V_M<$M×3.5 volts, wherein N and M are positive integrals denoting respective numbers of series connected LEDs in the first LED load and in the second LED load.

58. The lifestyle LED security light according to claim **55**, wherein the first mingled color temperature of the first level illumination in performing the first illumination mode is the low color temperature, wherein the second semiconductor switching device is in a cutoff state and the controller outputs only the first control signal to control the first conduction rate of the first semiconductor switching device to deliver the total electric power to the light-emitting unit to determine the light intensity of the first illumination mode.

59. The lifestyle LED security light according to claim **55**, wherein the second mingled color temperature of the second level illumination in performing the second illumination

mode is the high color temperature, wherein the first semiconductor switching device is in a cutoff state and the controller outputs only the second control signal to control the second conduction rate of the second semiconductor switching device to deliver the total electric power to the light-emitting unit to determine the light intensity of the second illumination mode.

60. The lifestyle LED security light according to claim **55**, wherein when the light-emitting unit is in the first illumination mode, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable to tune the mingled color temperature of the diffused light created thru the light diffuser; wherein upon receiving an external control signal from the external control unit the controller operates to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally decrease the second electric power delivered to the second LED load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally increase the second electric power delivered to the second LED load.

61. The lifestyle LED security light according to claim **60**, wherein when the light-emitting unit is in the first illumination mode, the controller is programmed to operate with a color temperature swicthing scheme, wherein paired combinations of different conduction rates between operating the first semiconductor switching device and the second semiconductor switching device for controlling the first electric power and the second electric power respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the at least one external control signal received and interpreted by the controller for performing a selected mingled color temperature.

62. The lifestyle LED security light according to claim **55**, wherein when the light-emitting unit is in the second illumination mode, the light intensity of the first LED load and the light intensity of the second LED load are respectively adjustable to tune the mingled color temperature thru the light diffuser; wherein upon receiving an external control signal from the at least one external control unit the controller operates to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally decrease the second electric power delivered to the second LED load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally increase the second electric power delivered to the second LED load.

63. The lifestyle LED security light according to claim **62**, wherein when the light-emitting unit is in the second illumination mode, the controller is programmed to operate with a color temperature switching scheme, wherein paired combinations of different condcution rates between operating the first semiconductor switching device and the second semiconductor switching device for controlling the first electric power and the second electric to be respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the external control signal received and interpreted by the controller for performing a selected mingled color temperature.

64. The lifestyle LED security light according to claim **62**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature tuning scheme.

65. The lifestyle LED security light according to claim **63**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature tuning scheme.

66. The lifestyle LED security light according to claim **61**, wherein the at least one external control unit includes at least one wireless signal receiver to receive a wireless external control signal from a mobile device, a smart phone or a smart speaker for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature switching scheme.

67. A lifestyle LED security light comprising:

a light-emitting unit, configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;

a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled color temperature;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

at least one external control unit; and

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically and respectively coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the at least one external control unit;

wherein the switching circuitry is electrically coupled between at least one power source of the power supply unit and the light-emitting unit, wherein the power source is a DC power source configured in the power supply unit;

wherein the switching circuitry comprises at least a first semiconductor switching device and a second semiconductor switching device;

wherein the first LED load and the second LED load are connected in parallel and are further respectively and electrically coupled to the first semiconductor switching device and the second semiconductor switching device;

wherein the controller outputs a first control signal to control a first conduction rate of the first semiconductor switching device for delivering a first electric power to the first LED load and simultaneously a second control signal to control a second conduction rate of the second semiconductor switching device for delivering a second electric power to the second LED load such that the light-emitting unit respectively generates illuminations of different light intensities and different mingled color temperatures for performing different illumination modes according to signals respectively received from the light sensing control unit, the motion sensing unit and the at least one external control unit;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on to perform a first illumination mode with the motion sensing unit being temporarily deactivated; wherein the controller outputs at least the first control signal to control at least the first conduction rate of at least the first semiconductor switching device such that a total electric power is delivered to the light-emitting unit to perform the first illumination mode with a first level illumination characterized by a first light intensity and a first mingled color temperature for a first predetermined time duration;

wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to reduce the total electric power delivered to the light-emitting unit to generate a low level illumination characterized by a low light intensity and at the same time the motion sensing unit is activated;

wherein when a motion signal is detected by the motion sensing unit, the controller operates to output at least the second control signal to control at least the second conduction rate of at least the second semiconductor switching device to increase the total electric power delivered to the light-emitting unit to perform a second illumination mode with a second level illumination characterized by a second light intensity and a second mingled color temperature for a second predetermined time duration before being switched back to the low level illumination, wherein the second light intensity of the second level illumination is equal to or higher than the first light intensity of the first level illumination, wherein the first light intensity is equal to or higher than the low light intensity of the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit including the first LED load and the second LED load is switched off;

wherein the at least one external control unit is a voltage divider, a push button, a touch pad, a wireless signal receiver or a power interruption detection circuitry, generating at least one external control signal for adjusting or selecting at least one operating parameter of the light-emitting unit including the light intensity, the mingled color temperature, a time length for the first predetermined time duration or a time length for the second predetermined time duration respectively in the first illumination mode or in the second illumination mode;

wherein the LEDs of the first LED load and the LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the power source of the power supply unit an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

68. The lifestyle LED security light according to claim **67**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the first LED load or the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

69. The lifestyle LED security light according to claim **68**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the working voltages imposed on the first LED load and the second LED load respectively represented by V_N and V_M are confined in domains expressed by N×2.5 volts $<V_N<$N×3.5 volts and M×2.5 volts $<V_M<$M×3.5 volts, wherein N and M are positive integrals denoting respective numbers of series connected LEDs in the first LED load and the second LED load.

70. The lifestyle LED security light according to claim **67**, wherein the first mingled color temperature in performing the first illumination mode is the low color temperature, wherein the second semiconductor switching device is in a cutoff state and the controller outputs only the first control signal to control the first conduction rate of the first semiconductor switching device to deliver the total electric power to the light-emitting unit to determine the light intensity and the mingled color temperature of the first illumination mode.

71. The lifestyle LED security light according to claim **67**, wherein the second mingled color temperature in performing the second illumination mode is the high color temperature, wherein the first semiconductor switching device is in a cutoff state and the controller outputs only the second control signal to control the second conduction rate of the second semiconductor switching device to deliver the total electric power to the light-emitting unit to determine the light intensity of the second illumination mode.

72. The lifestyle LED security light according to claim **67**, wherein when the light-emitting unit is in the first illumination mode, a light intensity of the first LED lighting load and a light intensity of the second LED lighting load are respectively adjustable to tune the mingled color temperature of the diffused light thru the light diffuser; wherein upon receiving an external control signal from the at least one external control unit the controller operates to simultaneously but reversely adjust the light intensity of the first LED lighting load and the light intensity of the second LED

lighting load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time proportionally decrease the second electric power delivered to the second LED load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time proportionally increase the second electric power delivered to the second LED load.

73. The lifestyle LED security light according to claim **72**, wherein when the light-emitting unit is in the first illumination mode, the controller is programmed to operate with a color temperature tuning scheme, wherein paired combinations of different conduction rates between operating the first semiconductor switching device and the second semiconductor switching device for controlling the first electric power and the second electric power respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the external control signal received and interpreted by the controller for performing a selected mingled color temperature.

74. The lifestyle LED security light according to claim **67**, wherein when the light-emitting unit is in the second illumination mode, a light intensity of the first LED lighting load and a light intensity of the second LED lighting load are respectively adjustable to tune the mingled color temperature thru the light diffuser; wherein upon receiving an external control signal from the at least one external control unit the controller operates to simultaneously but reversely adjust the light intensity of the first LED lighting load and the light intensity of the second LED lighting load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally decrease the second electric power delivered to the second LED load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally increase the second electric power delivered to the second LED load.

75. The lifestyle LED security light according to claim **74**, wherein when the light-emitting unit is in the second illumination mode, the controller is programmed to operate with a color temperature tuning scheme, wherein paired combinations of different conduction rates between operating the first semiconductor switching device and the second semiconductor switching device for controlling the first electric power and the second electric power respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the external control signal received and interpreted by the controller for performing a selected mingled color temperature.

76. The lifestyle LED security light according to claim **73**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature tuning scheme.

77. The lifestyle LED security light according to claim **75**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature tuning scheme.

78. The lifestyle LED security light according to claim **73**, wherein the at least one external control unit include at least one wireless signal receiver to receive a wireless external control signal from a mobile device, a smart phone or a smart speaker for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature switching scheme.

79. A lifestyle LED security light, comprising:

a light-emitting unit, including at least a first LED load configured with a plurality of LEDs emitting light with a first color temperature;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a time setting unit; and

a power supply unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the time setting unit, wherein the switching circuitry is electrically connected between a power source and the light-emitting unit to control and output an electric power to the light-emitting unit, wherein the switching circuitry comprises at least a first semiconductor switching device, wherein the controller outputs a control signal to control a conduction rate of the switching circuitry for delivering different electric powers from the power source to drive the light-emitting unit for generating different illuminations characterized by different light intensities according to signals respectively received from the light sensing control unit and the motion sensing unit;

wherein the power source configured in the power supply unit outputs at least a DC power for operating the LED lighting device;

wherein the control signals are pulse width modulation signals;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit is activated to switch on the light-emitting unit to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion signal is detected by the motion sensing unit, the loading and power control unit in response manages to increase the electric power delivered to the light-emitting unit to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein the light intensity of the second level

illumination is higher than the light intensity of the first level illumination, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit is activated to switch off the light-emitting unit;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during a performance of the first illumination mode, the low level illumination creates three advantages for performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein a third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff while a person is still in the detection space due to expiration of a timer and a simple motion by the person can immediately bring the LED security light back to the high level illumination;

wherein a configuration of the plurality of LEDs of the light-emitting unit is designed with a combination of in series and/or in parallel connections such that when incorporated with a level setting of the DC power, an electric current passing through each LED of the light-emitting unit remains at a level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction.

80. The lifestyle LED security light according to claim **79**, wherein the first LED load of the light-emitting unit is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the light-emitting unit is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

81. The lifestyle LED security light according to claim **80**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<3.5$ volts and the working voltage imposed on the light-emitting unit represented by V_N is confined in domains expressed by N×2.5 volts $<V_N<$N×3.5 volts, wherein N is the number of LEDs electrically connected in series in the first LED load of the light emitting unit.

82. The lifestyle LED security according to claim **79**, wherein the power supply unit is configured with an AC/DC power converter to convert an AC power into a least one DC power required for operating the LED security light.

83. The lifestyle LED security light according to claim **79**, wherein the power supply unit comprises a battery module to output at least one DC power for operating the lifestyle LED security light.

84. The lifestyle LED security light according to claim **83**, wherein the battery module is a rechargeable battery module.

85. The lifestyle LED security light according to claim **84**, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

86. The lifestyle LED security light according to claim **79**, wherein a wireless remote control device is further installed and is electrically coupled with the controller, wherein the remote control device is configured with a wireless receiver and a wireless transmitter to receive a motion intrusion signal detected from a neighboring LED security light and/or to transmit the motion intrusion signal to at least one neighboring LED security light;

wherein when the motion intrusion signal is detected by the motion sensing unit, the controller synchronously operates to transmit the motion intrusion signal thru the wireless transmitter to control a lighting performance of at least one neighboring LED security light;

wherein when the motion intrusion signal detected from a neighboring LED security light is received by the wireless receiver, the controller operates to synchronously increase the conduction rate of the switching device to increase the electric power delivered to the light-emitting unit to perform the high level illumination for the second predetermined time duration.

87. The lifestyle LED security light according to claim **86**, wherein the wireless signal for operating the wireless remote control device is a Wi-Fi wireless signal, a Blue Tooth wireless signal, a Zig Bee wireless signal, or a radio frequency wireless signal.

88. The lifestyle LED security light according to claim **79**, wherein a second LED load to emit light with a second color temperature is further installed in the light emitting unit to be in parallel with the first LED load; wherein a light diffuser is further installed to cover the first LED load and the second LED load, wherein the first color temperature is a low color temperature and the second color temperature is a high color temperature; wherein a second semiconductor switching device and a third semiconductor switching device are further installed between the switching circuitry and the light emitting unit; wherein the second semiconductor switching device is electrically coupled between the switching circuitry and the first LED load, wherein the third semiconductor switching device is electrically coupled between the switching circuitry and the second LED load, wherein the second semiconductor switching device and the third semiconductor switching device are electrically coupled with the controller to form a power allocation circuitry for dividing the electric power from the switching circuitry into a first electric power delivered to the first LED load and a second electric power delivered to the second LED load; wherein at least one external control device operable by a user is further installed to be electrically coupled with the controller generating at least one external control signal to the controller, wherein upon receiving the at least one external control signal the controller responsively outputs at least a first control signal to control a conduction rate of the second semiconductor switching device and at least a second control signal to control the conduction rate of the third semiconductor switching device to respectively deliver the first electric power to the first LED load and the second electric power to the second LED load to generate the illumination with a mingled color temperature thru the light diffuser;

wherein for changing to a lower mingled color temperature, the controller upon receiving the at least one external control signal operates to control the second semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the third semiconductor switching device to decrease the second electric power delivered to the second LED load such that a total of the first electric power and the second electric power remains unchanged;

wherein for changing to a higher mingled color temperature, the controller upon receiving the at least one external control signal operates to control the second semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the third semiconductor switching device to increase the second electric power

delivered to the second LED load such that the total of the first electric power and the second electric power remains unchanged.

89. The lifestyle LED security light according to claim **88**, wherein the controller is programmed to operate with at least one color temperature switching scheme for selecting the mingled color temperature of the first level illumination mode or the mingled color temperature of the second level illumination mode, wherein paired combinations of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the at least one external control signal received and interpreted by the controller for performing a selected mingled color temperature.

* * * * *

EXHIBIT G

US010763691B2

(12) **United States Patent**
Chen

(10) **Patent No.: US 10,763,691 B2**
(45) **Date of Patent: *Sep. 1, 2020**

(54) **TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR**

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(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

(73) Assignee: **Vaxcel International Co., Ltd.**, Carol Stream, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/823,944**

(22) Filed: **Mar. 19, 2020**

(65) **Prior Publication Data**

US 2020/0220377 A1 Jul. 9, 2020

Related U.S. Application Data

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(Continued)

(51) **Int. Cl.**

H05B 37/02 (2006.01)
H02J 7/35 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H02J 7/35*** (2013.01); ***F21S 9/03*** (2013.01); ***F21V 17/02*** (2013.01); ***G08B 5/36*** (2013.01); ***G08B 13/1895*** (2013.01); ***G08B 15/00*** (2013.01); ***G08B 15/002*** (2013.01); ***H05B 39/042*** (2013.01); ***H05B 39/044*** (2013.01); ***H05B 45/10*** (2020.01); ***H05B 45/14*** (2020.01); ***H05B 45/20*** (2020.01); ***H05B 45/37*** (2020.01); ***H05B 45/44*** (2020.01); ***H05B 45/46*** (2020.01); ***H05B 45/48*** (2020.01); ***H05B 47/10*** (2020.01); ***H05B 47/105*** (2020.01); ***H05B 47/11*** (2020.01); ***H05B 47/16*** (2020.01);

(Continued)

(58) **Field of Classification Search**

CPC H05B 33/0815; H05B 33/0824; H05B 33/083; H05B 33/0845; H05B 33/0854; H05B 33/0872; H05B 37/0218; H05B 37/0227; H05B 37/0281; H05B 37/0272

USPC 315/149, 152, 154, 307, 308, 312

See application file for complete search history.

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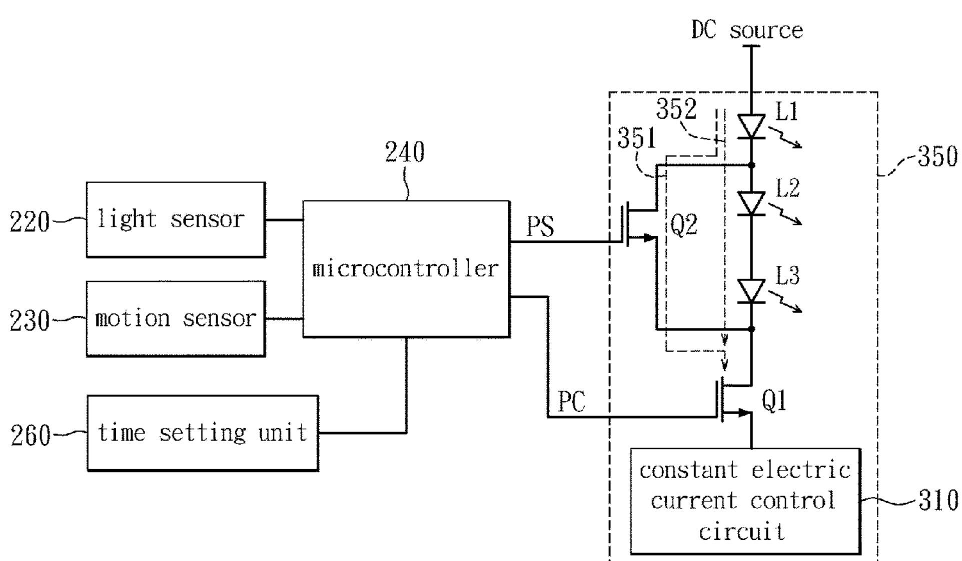
Primary Examiner — Tung X Le

(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A technology for configuring a lifestyle LED light with a tunable light color temperature is disclosed. The technology of tuning the light color temperature is made possible by blending two LED loads emitting light with different color temperatures thru a light diffuser with an arrangement that a first electric power delivered to a first LED load emitting light with a low color temperature and a second electric power delivered to a second LED load emitting light with a high color temperature are reversely and complementarily adjusted for tuning a diffused light color temperature such that a total light intensity generated by the LED light is kept essentially unchanged.

83 Claims, 18 Drawing Sheets



Related U.S. Application Data

No. 16/244,671, filed on Jan. 10, 2019, now Pat. No. 10,516,292, which is a continuation of application No. 15/896,403, filed on Feb. 14, 2018, now Pat. No. 10,225,902, which is a continuation of application No. 15/785,658, filed on Oct. 17, 2017, now Pat. No. 10,326,301, which is a continuation of application No. 15/375,777, filed on Dec. 12, 2016, now Pat. No. 9,826,590, which is a continuation of application No. 14/836,000, filed on Aug. 26, 2015, now Pat. No. 9,622,325, which is a division of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

(51) **Int. Cl.**

H05B 45/10	(2020.01)
H05B 45/14	(2020.01)
H05B 45/20	(2020.01)
H05B 45/37	(2020.01)
H05B 45/44	(2020.01)
H05B 45/46	(2020.01)
H05B 45/48	(2020.01)
H05B 47/10	(2020.01)
H05B 47/11	(2020.01)
H05B 47/16	(2020.01)
H05B 47/105	(2020.01)
G08B 15/00	(2006.01)
H05B 39/04	(2006.01)
F21S 9/03	(2006.01)
F21V 17/02	(2006.01)
G08B 5/36	(2006.01)
G08B 13/189	(2006.01)
F21Y 115/10	(2016.01)
G08B 13/00	(2006.01)

(52) **U.S. Cl.**

CPC *F21Y 2115/10* (2016.08); *G08B 13/00* (2013.01); *G08B 13/189* (2013.01); *Y02B 20/40* (2013.01); *Y02B 20/44* (2013.01); *Y02B 20/46* (2013.01)

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2005/0127381 A1*	6/2005	Vitta	F21K 9/00 257/88
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2012/0049760 A1	3/2012	Dennis et al.	
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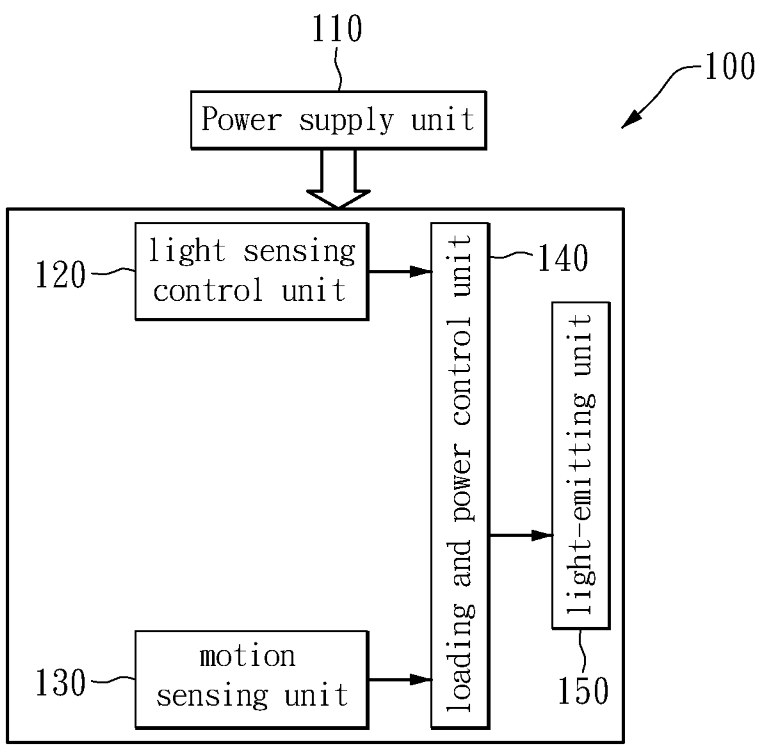

110
100
Power supply unit
120
light sensing control unit
140
loading and power control unit
light-emitting unit
130
motion sensing unit
150

FIG. 1

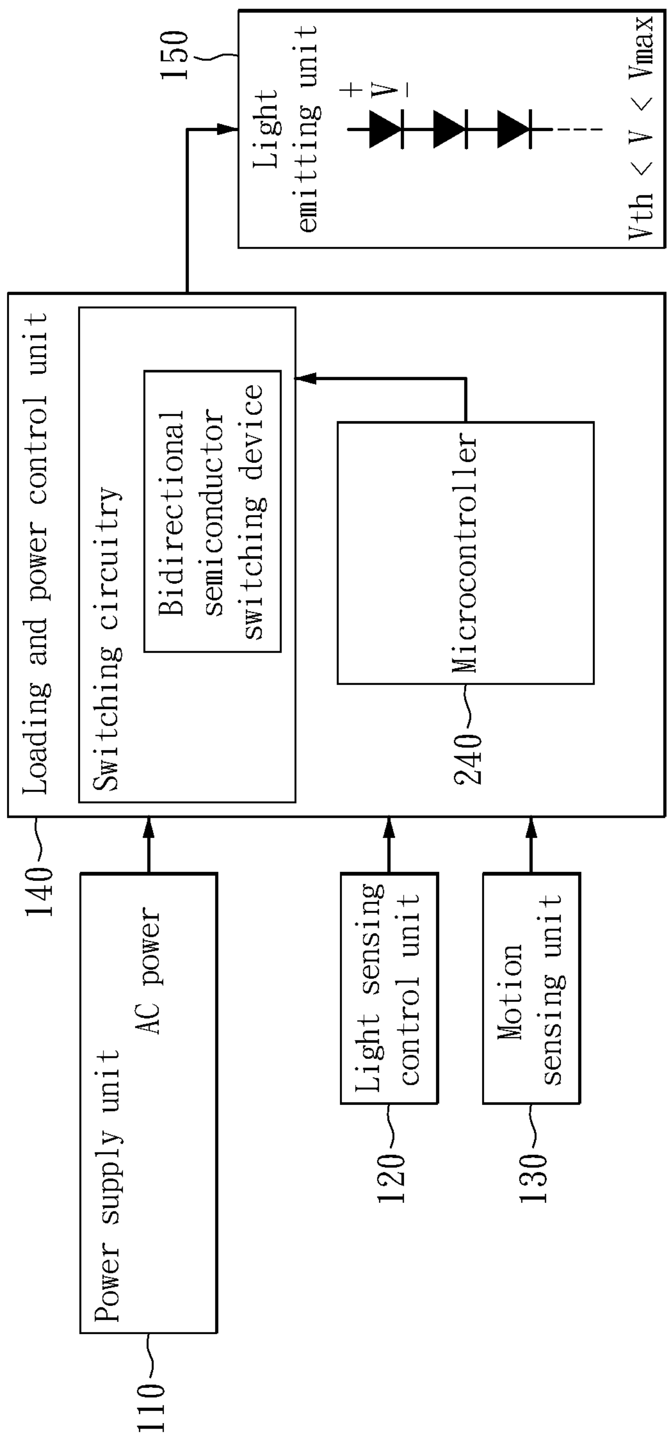

Power supply unit
AC power
110
Light sensing control unit
120
Motion sensing unit
130
Loading and power control unit
140
Switching circuitry
Bidirectional semiconductor switching device
Microcontroller
240
Light emitting unit
150
+ V −
Vth < V < Vmax

FIG. 1A

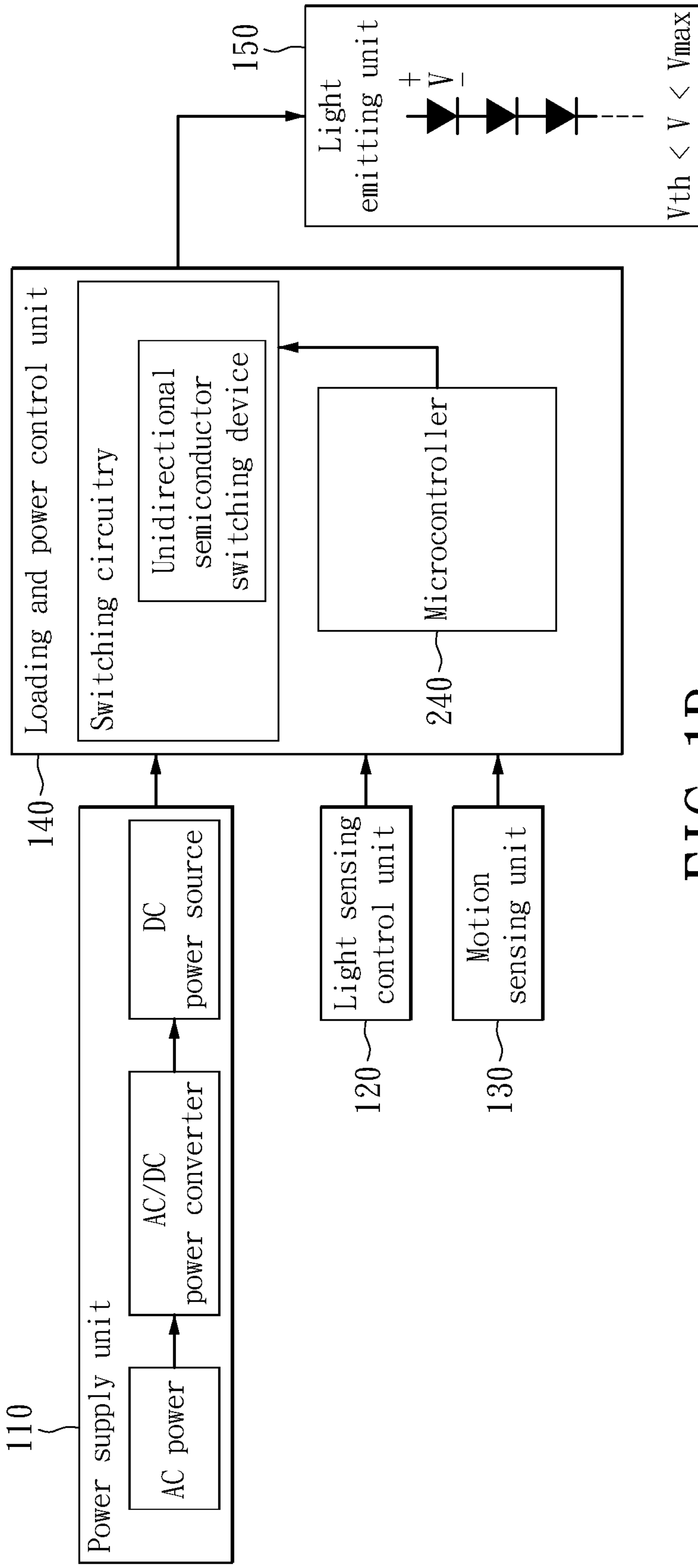

110
Power supply unit
AC power
AC/DC power converter
DC power source
140
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
120
Light sensing control unit
130
Motion sensing unit
150
Light emitting unit
+ V −
Vth < V < Vmax

FIG. 1B

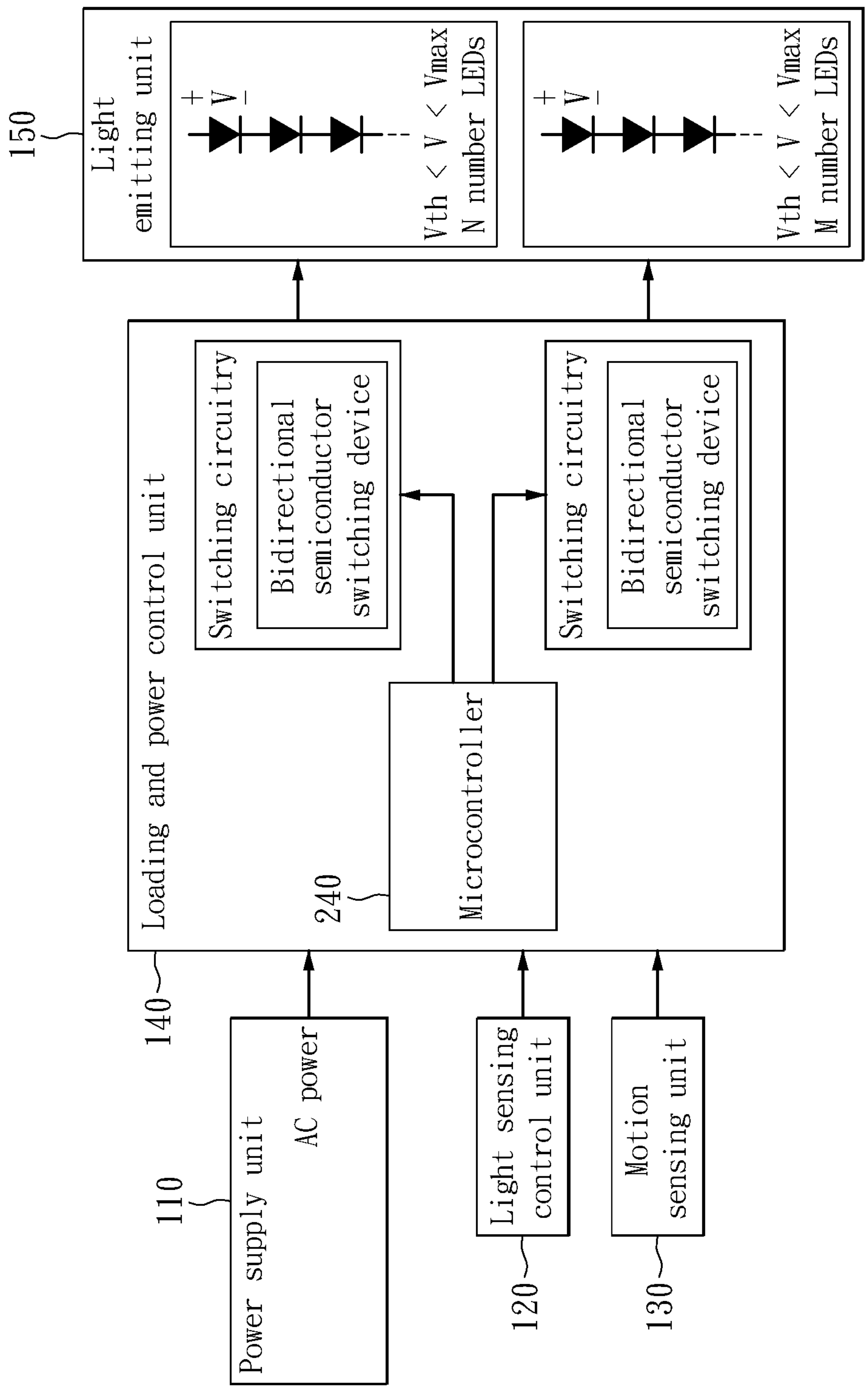

150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Switching circuitry
Bidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
Light sensing control unit
120
Motion sensing unit
130

FIG. 1C

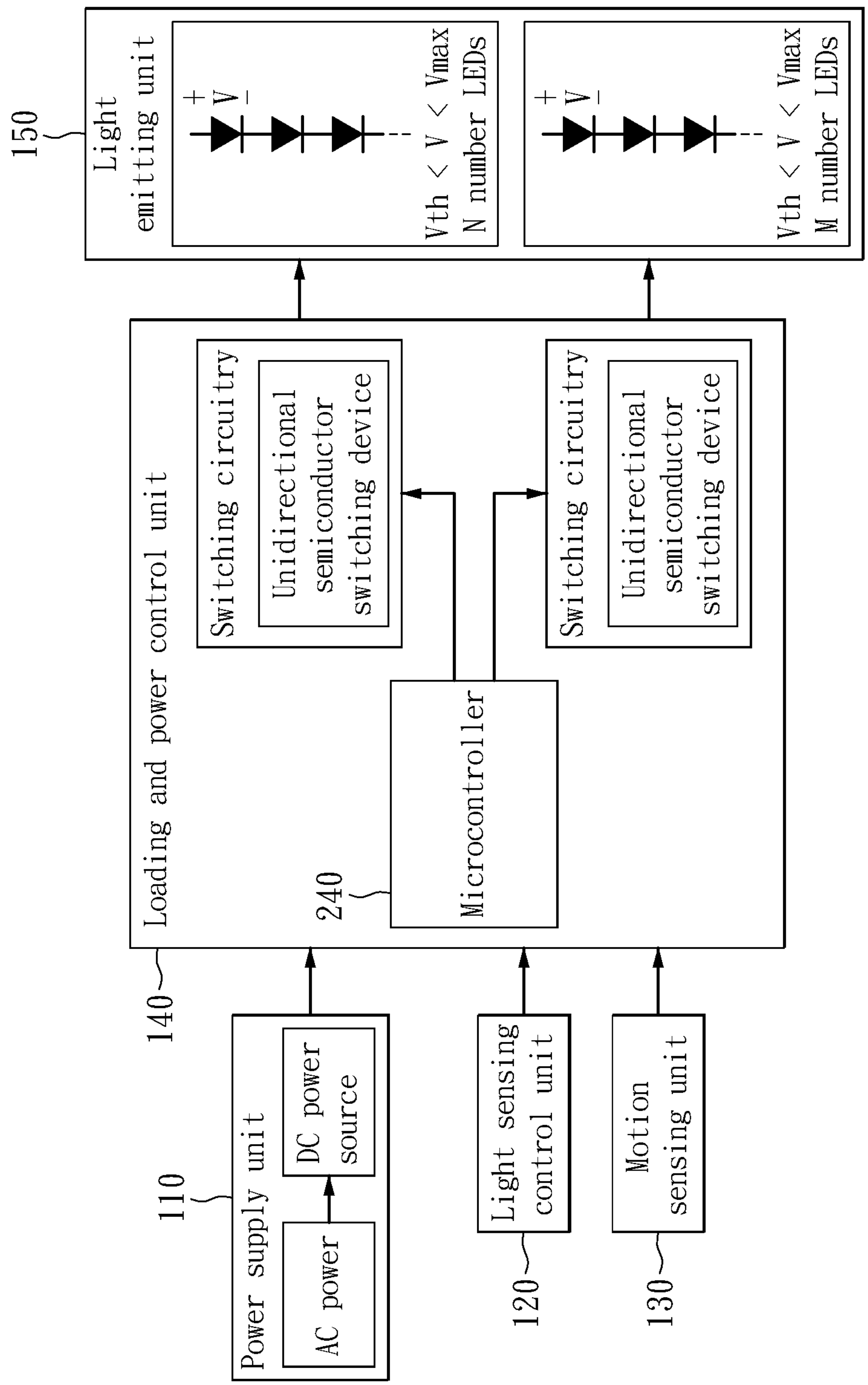

150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Switching circuitry
Unidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
DC power source
Light sensing control unit
120
Motion sensing unit
130

FIG. 1D

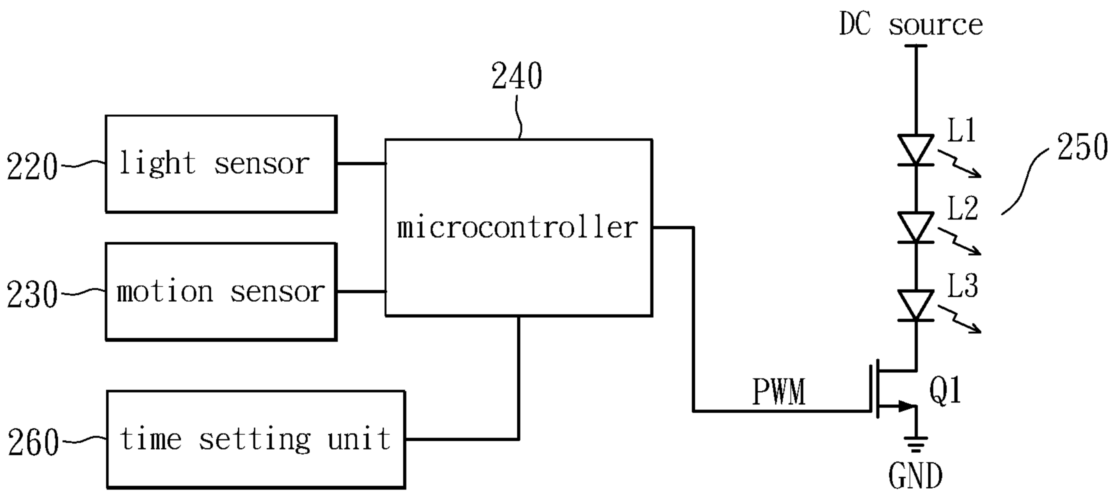

DC source
240
220
light sensor
microcontroller
L1
250
L2
230
motion sensor
L3
PWM
Q1
260
time setting unit
GND

FIG. 2A

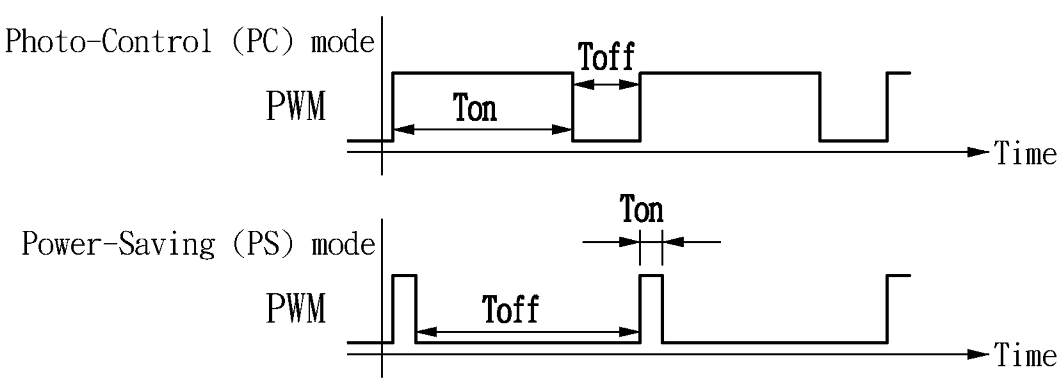
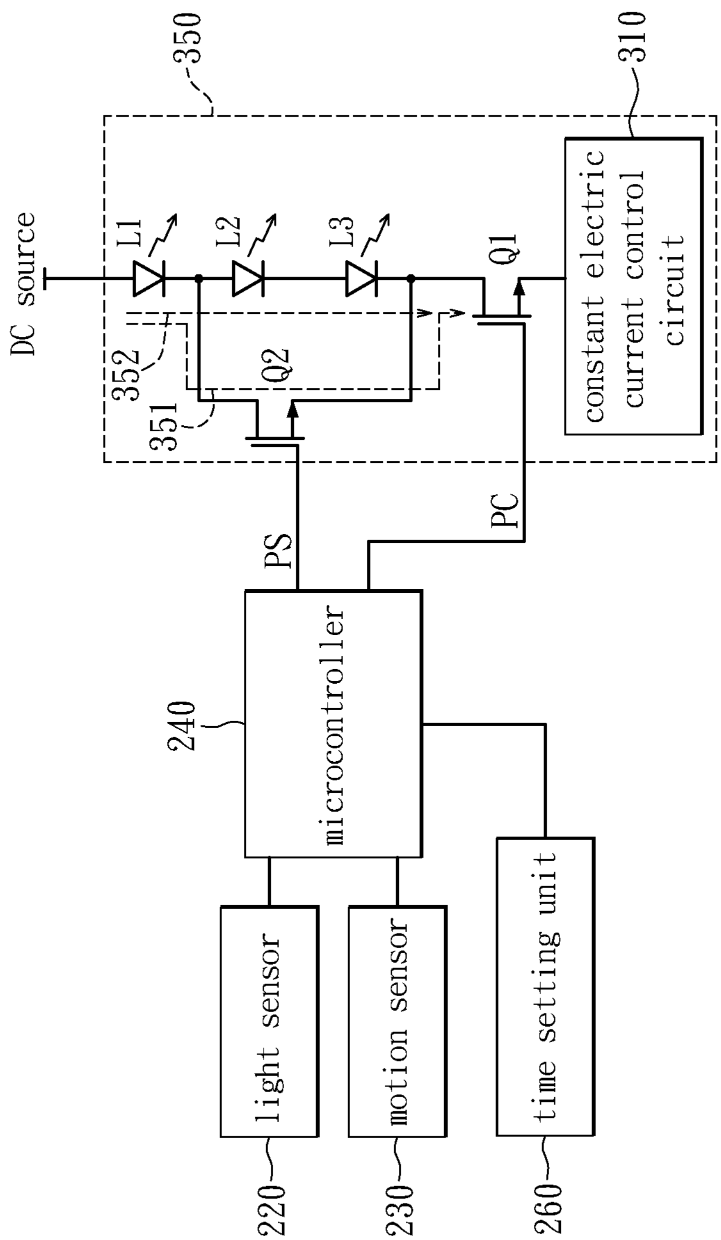


Photo-Control (PC) mode
Toff
PWM
Ton
Time
Ton
Power-Saving (PS) mode
PWM
Toff
Time

FIG. 2B



DC source
L1
L2
L3
Q1
Q2
350
310
352
351
constant electric current control circuit
PS
PC
microcontroller
240
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

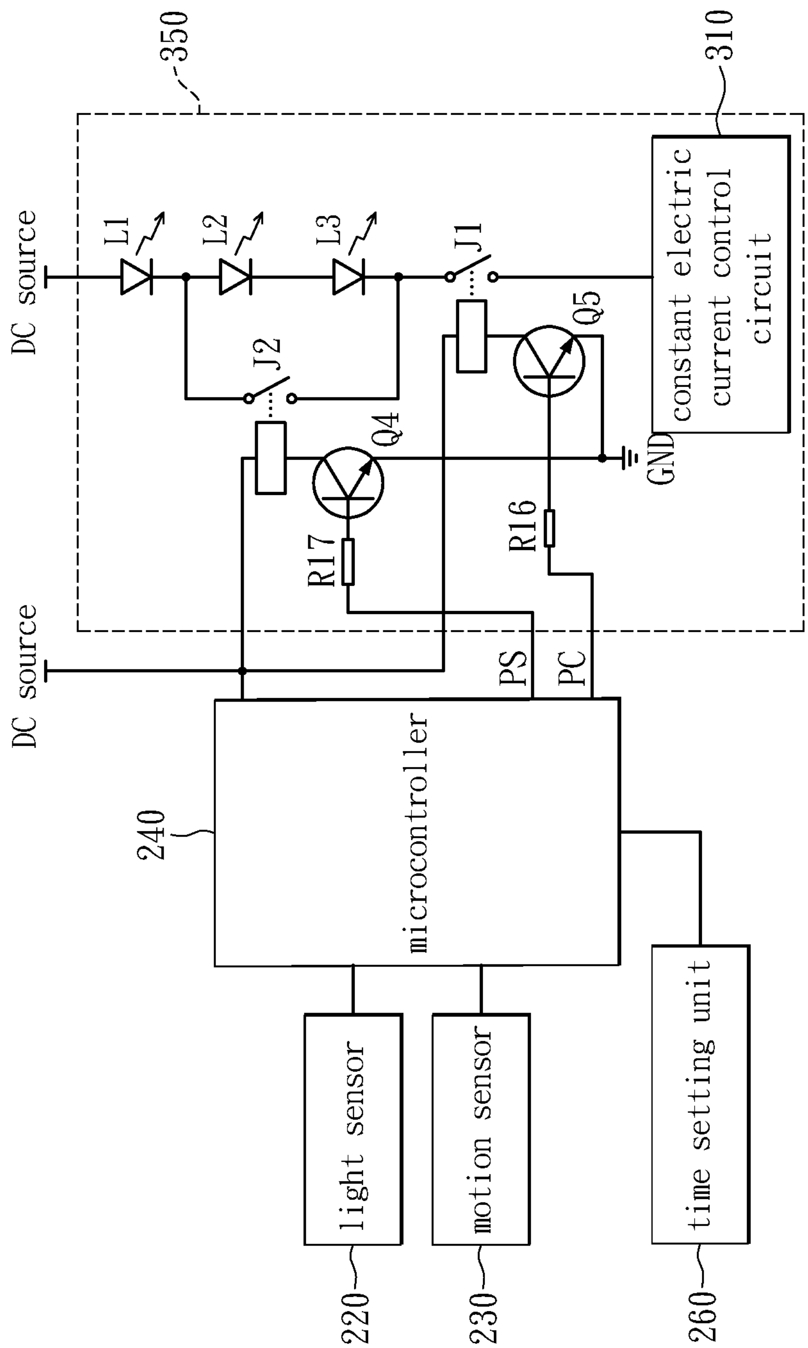

350
310
DC source
L1
L2
L3
J1
J2
Q4
Q5
GND
R16
R17
constant electric current control circuit
DC source
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

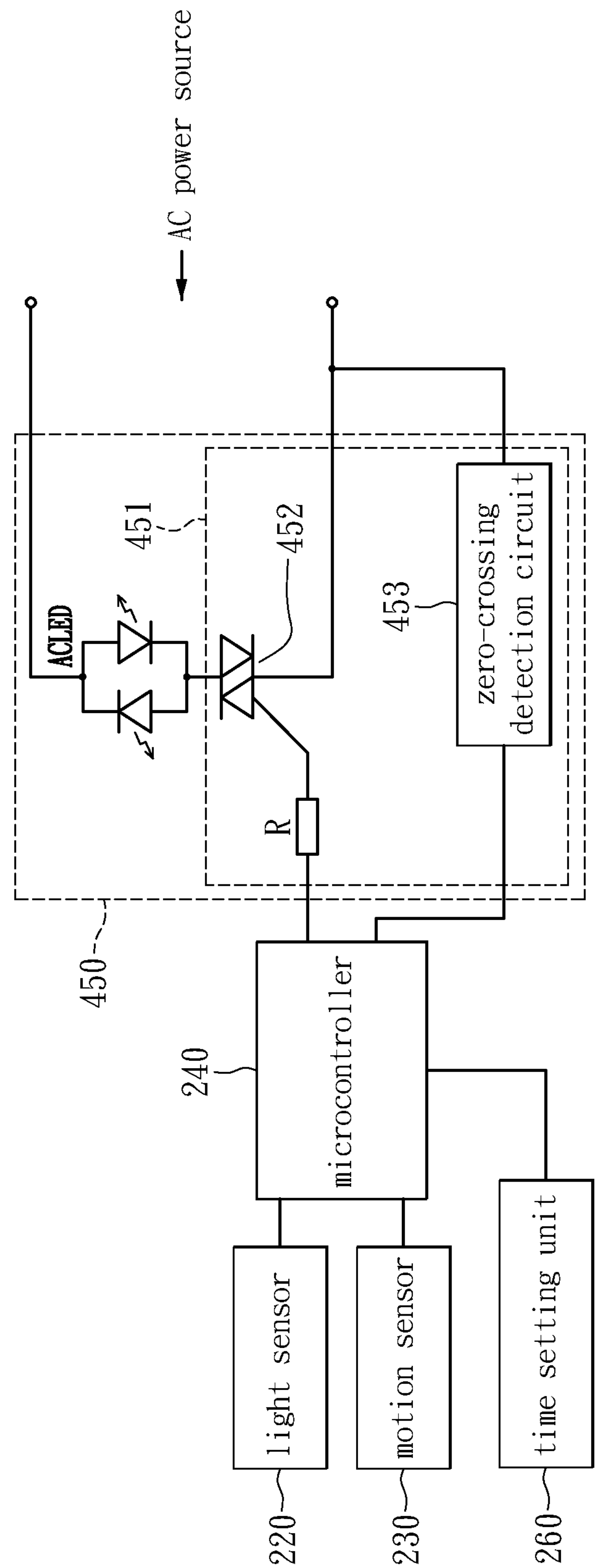

AC power source
ACLED
451
452
453
zero-crossing detection circuit
R
450
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

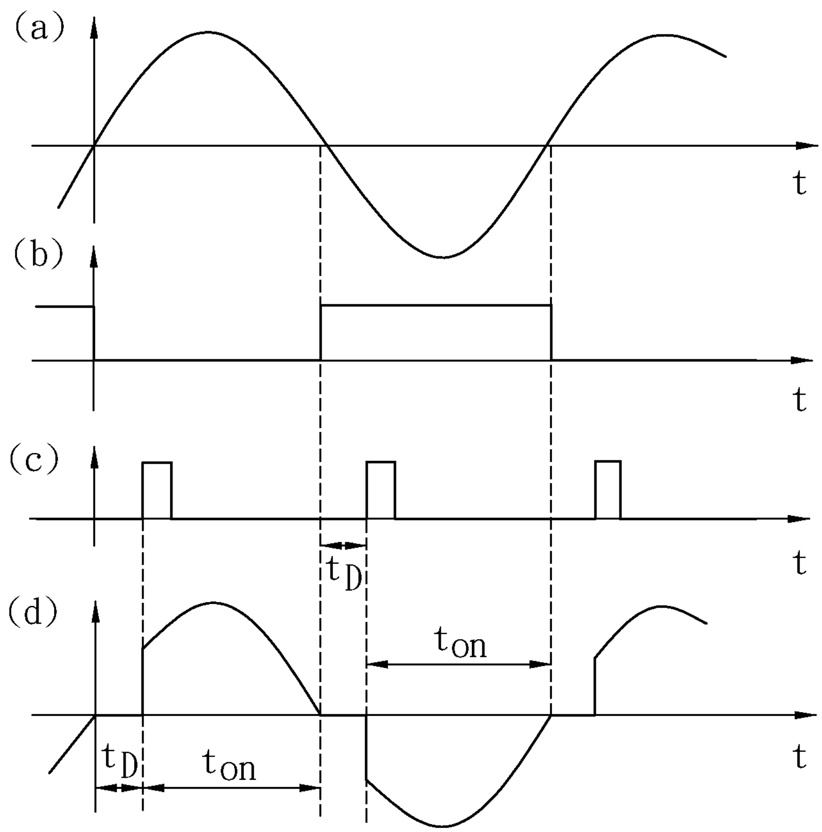


FIG. 4B

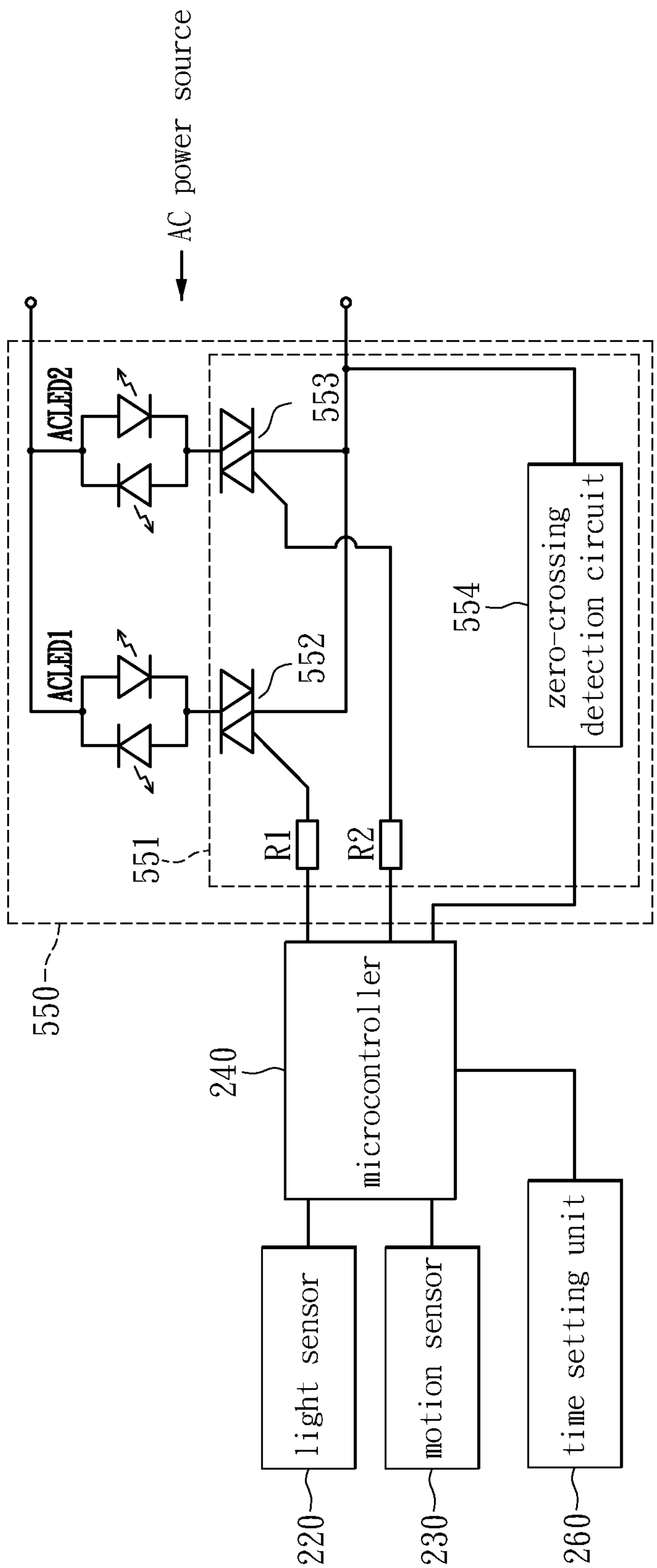

AC power source
ACLED1
ACLED2
551
552
553
554
R1
R2
zero-crossing detection circuit
550
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

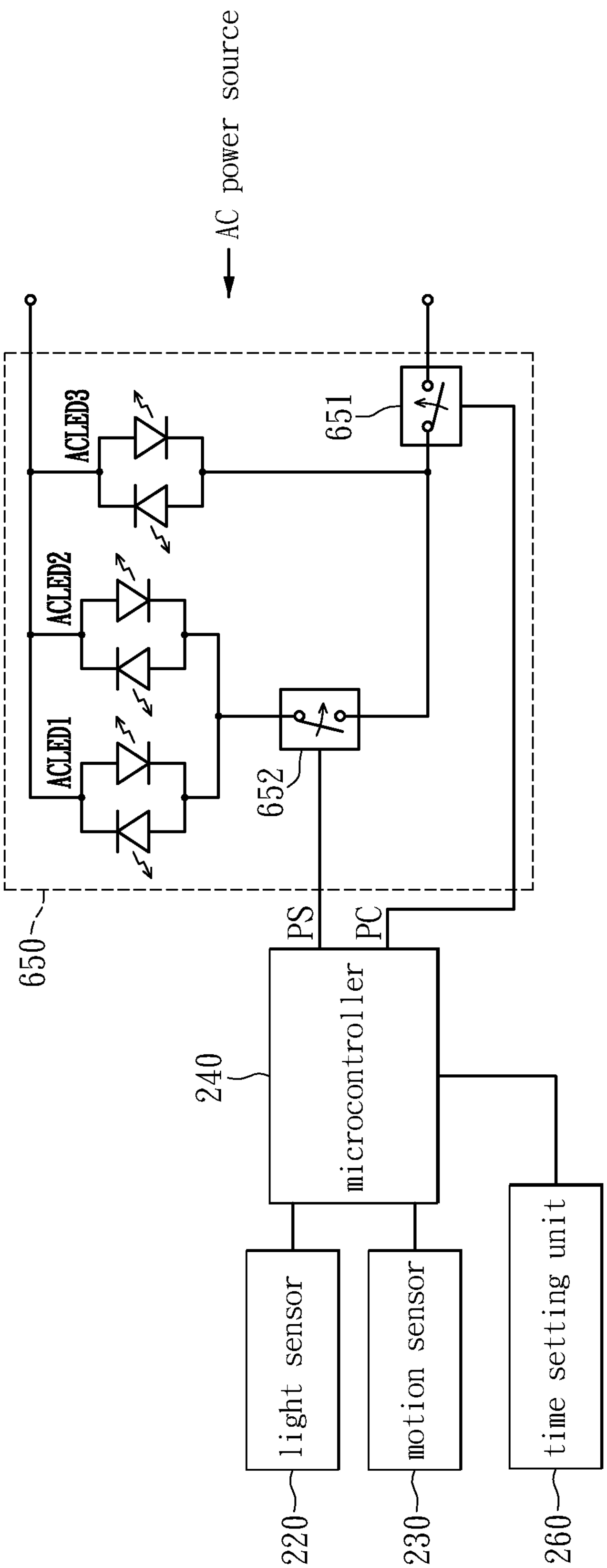

AC power source
ACLED1
ACLED2
ACLED3
651
652
650
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

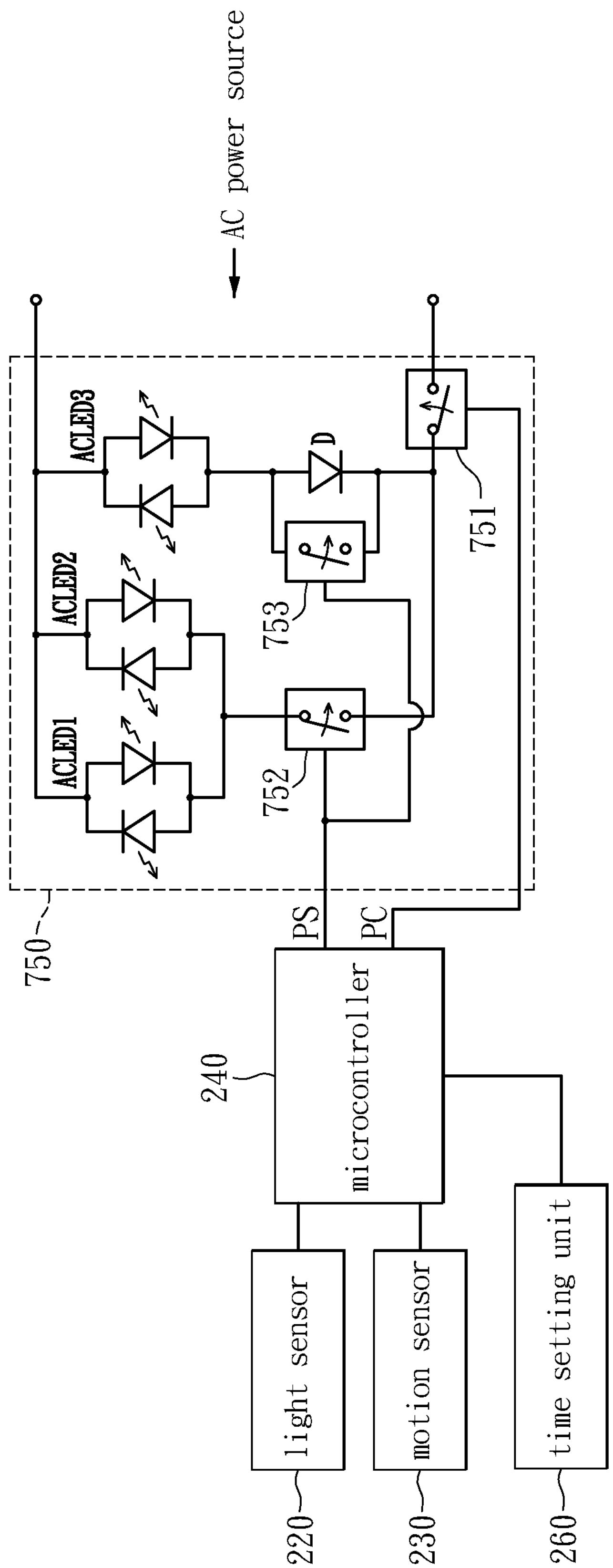

AC power source
ACLED3
ACLED2
ACLED1
D
751
753
752
750
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

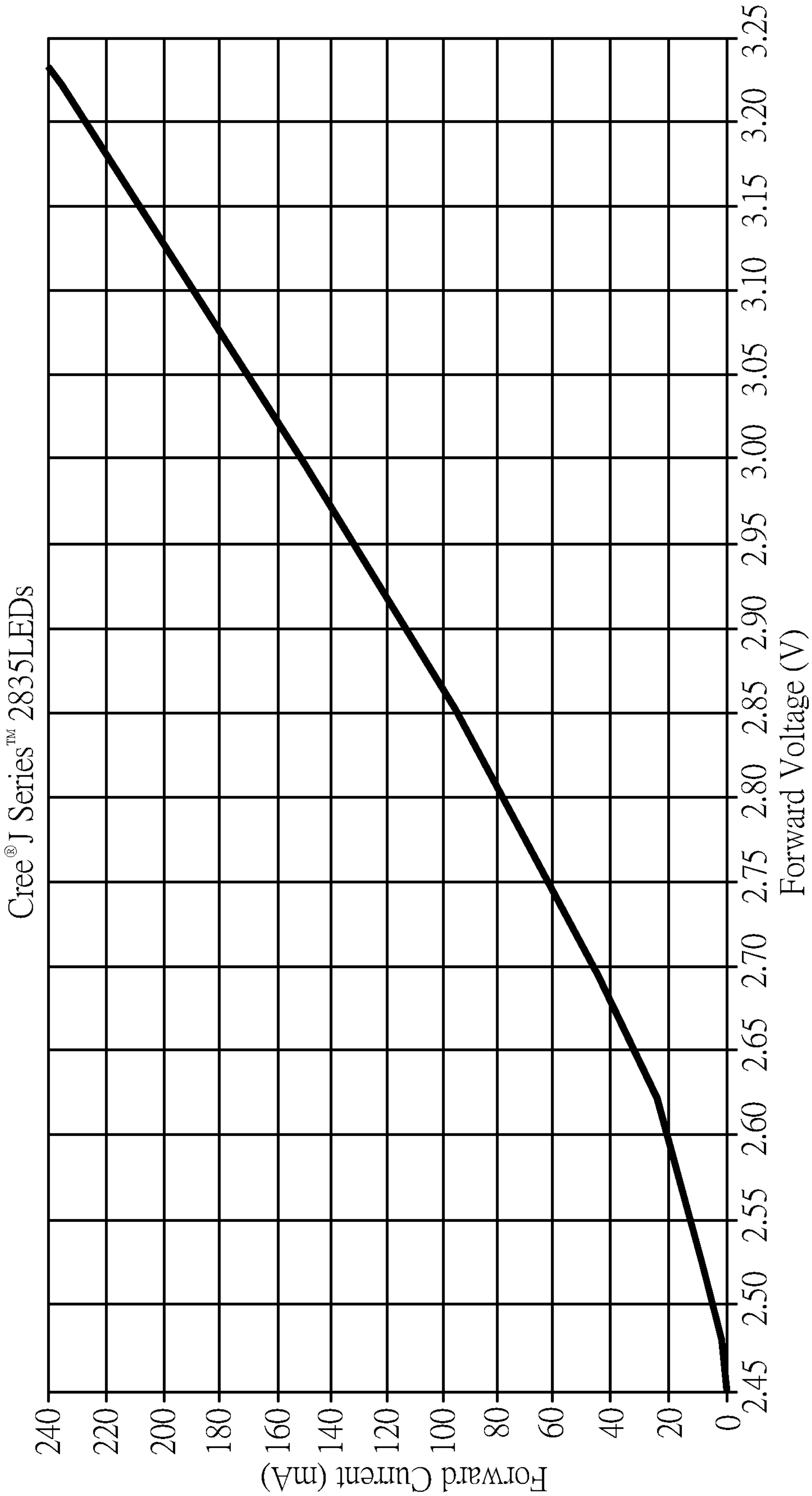

Cree® J Series™ 2835LEDs
Forward Current (mA)
240
220
200
180
160
140
120
100
80
60
40
20
0
Forward Voltage (V)
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25

FIG. 8A

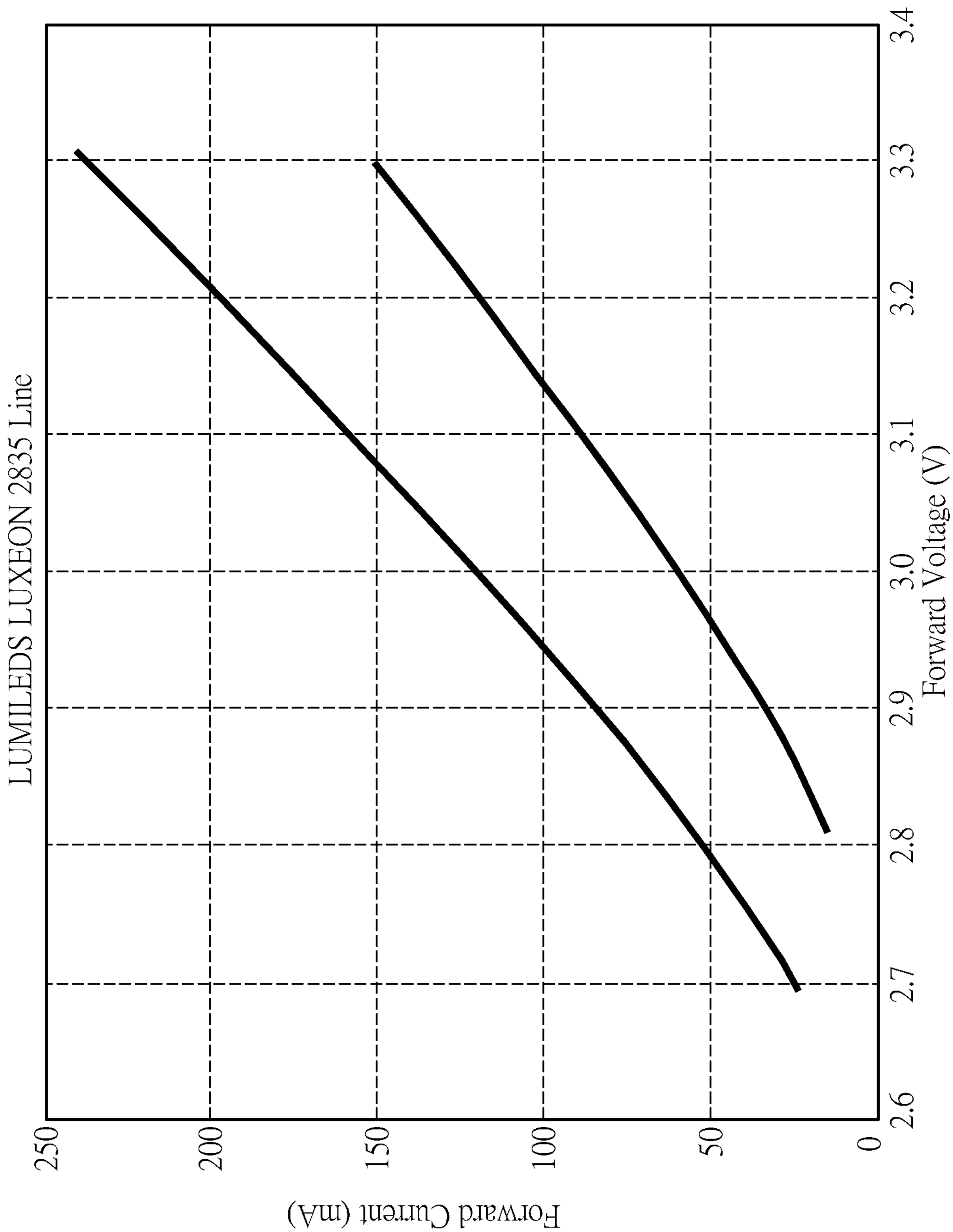

LUMILEDS LUXEON 2835 Line
Forward Current (mA)
250
200
150
100
50
0
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4

FIG. 8B

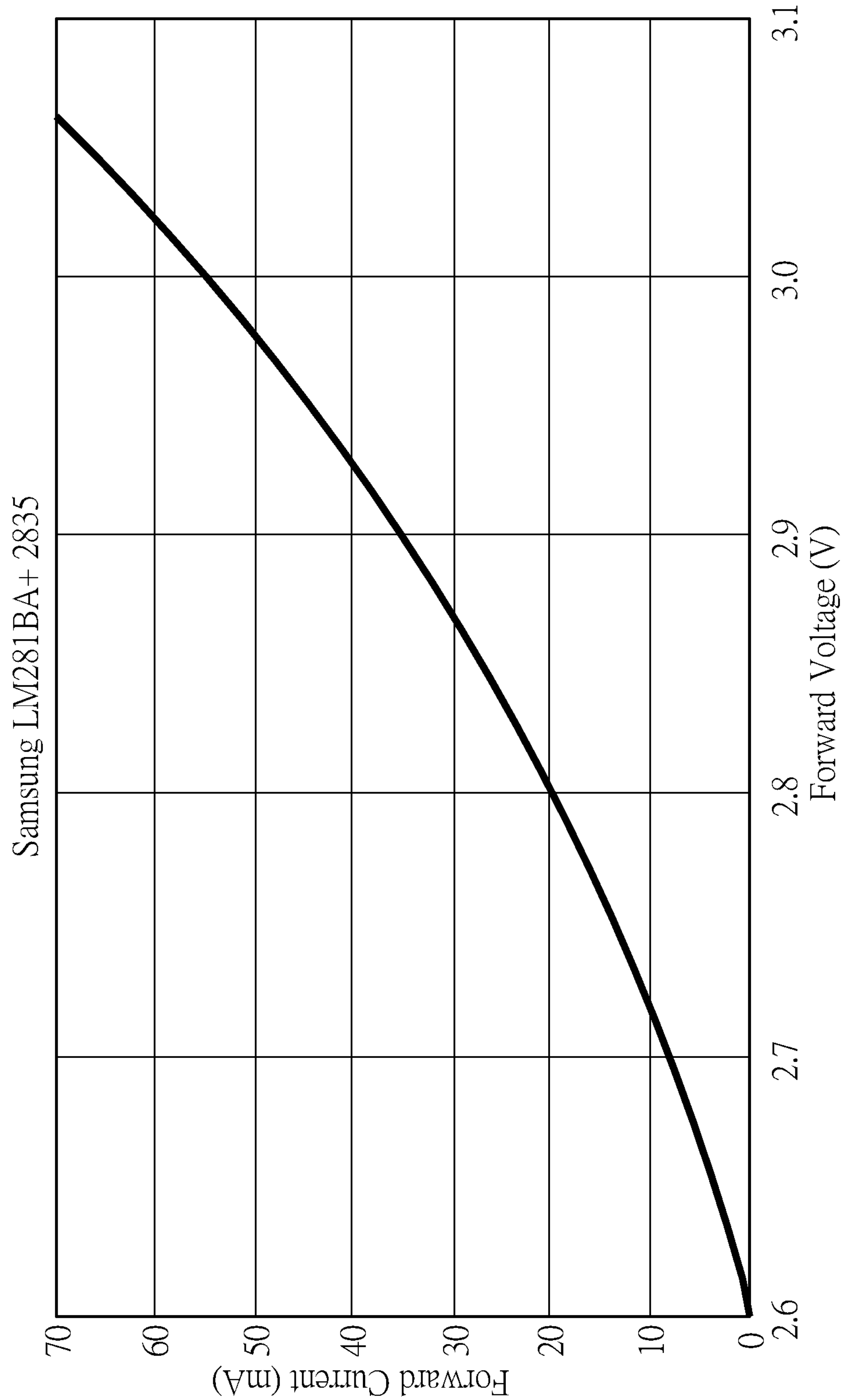

Samsung LM281BA+ 2835
Forward Current (mA)
0
10
20
30
40
50
60
70
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1

FIG. 8C

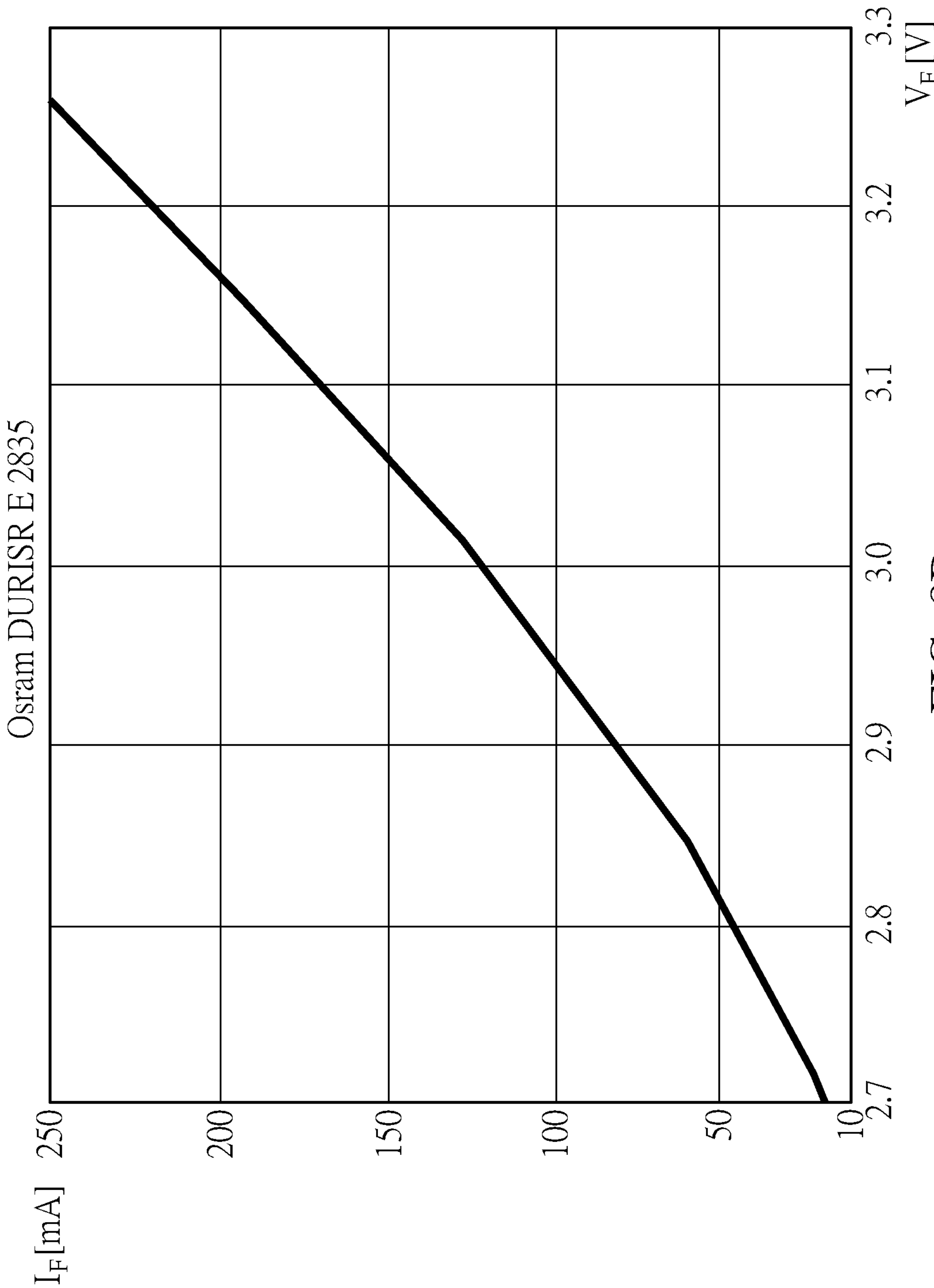

Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
2.7
2.8
2.9
3.0
3.1
3.2
3.3
V_F [V]

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation of application Ser. No. 16/668,599, filed Oct. 30, 2019, which is pending now. Ser. No. 16/668,599 is a continuation of application Ser. No. 16/244,671, filed Jan. 10, 2019, which issued as U.S. Pat. No. 10,516,292 on Dec. 24, 2019. U.S. Pat. No. 10,516,292 is a continuation of application Ser. No. 15/896,403, filed Feb. 14, 2018, which issued as U.S. Pat. No. 10,225,902 on Mar. 5, 2019. U.S. Pat. No. 10,225,902 is a continuation of application Ser. No. 15/785,658, filed Oct. 17, 2017, which issued as U.S. Pat. No. 10,326,301 on Jun. 18, 2019. U.S. Pat. No. 10,326,301 is a continuation of application Ser. No. 15/375,777, filed Dec. 12, 2016, which issued as U.S. Pat. No. 9,826,590 on Nov. 21, 2017. U.S. Pat. No. 9,826,590 is a continuation of application Ser. No. 14/836,000, filed Aug. 26, 2015, which issued as U.S. Pat. No. 9,622,325 on Apr. 11, 2017. U.S. Pat. No. 9,622,325 is a divisional of application Ser. No. 14/478,150, filed Sep. 5, 2014, which issued as U.S. Pat. No. 9,445,474 on Sep. 13, 2016. U.S. Pat. No. 9,445,474 is a continuation of application Ser. No. 13/222,090, filed Aug. 31, 2011, which issued as U.S. Pat. No. 8,866,392 on Oct. 21, 2014.

BACKGROUND OF THE INVENTION

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photoresistors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY OF THE INVENTION

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor

which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a phase controller and one or a plurality of parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power

supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto-turnoff at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediate switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an AC LED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the AC LED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **1**C is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a AC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises bidirectional semiconductor switching devices for controlling an average electric power to be delivered to the AC LED.

FIG. **1**D is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises unidirectional semiconductor switching devices for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C and **8**D schematically and respectively show I-V relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. A two-level LED security light (herein as the lighting apparatus)**100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs and switching components. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that the ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flow through the light-emitting unit **150**, to generate the high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein the DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a pulse width modulation (PWM) signal to the gate of transistor Q**1** to control the average electric current. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{off} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow the user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto. The time setting unit is a type of external control units designed to detect various external control signals and to convert the various external control signals into various message signals interpretable by the controller for setting various operating parameters of a security light including at least a time length setting for various illumination modes, a light intensity setting for various illumination modes and switching between illumination modes. The external control units may be configured with a push button, a touch sensor, a voltage

divider, a power interruption detection circuitry or a wireless remote control receiver for generating message signals interpretable by the controller.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. **3**A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A and FIG. **2**A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** detects that the ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may include a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include a phase controller and one or more parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** includes a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is

higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger thetriac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_0<t_D<½f-t_0$ for a light-source load with a cut-in voltage V_t, wherein $t_0=(½\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t (rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_0=2.2 ms and (½f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D<6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**, and a phase controller **551**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLEDs and more than one bi-directional switching devices. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED land ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the

light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1**~**3** having identical luminous power as well as switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1**~**3** are coupled to the AC power source and the light-emitting unit **650** may generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED3 is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ALCED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1-3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751**~**753** to render ACLED**1**~**3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs. In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

When the light source of the light-emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of a voltage operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the voltage operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the threshold voltage and the maximum working voltage.

In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as the threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is the threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the threshold voltage into a

corresponding time phase of AC power for lighting control, it is necessary to use the term V_{th} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V is a voltage across the LED chip, V_{th} is the threshold voltage to enable the LED chip to start emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working voltage V of each single LED chip is required to operate in a domain between a threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage V_N of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a threshold voltage of N times V_{th} ($N\times V_{th}$) and a maximum working voltage of N times V_{max} ($N\times V_{max}$) or $N\times V_{th}<V_N<N\times V_{max}$, wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V_N across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N\times V_{th}<V_N<N\times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises 4 drawings schematically and respectively showing a I-V relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage, i.e., the threshold voltage or the cut-in voltage, and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers. The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount of monetary relief was claimed with the Court in the complaint.

The present disclosure of a two-level LED security light provides a unique life-style lighting solution. The motivation of creating such life-style lighting solution has less to do with the energy saving aspect of the low level illumination mode because an LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the life-style lighting solution of the present disclosure is featured with two innovations which meaningfully improve the exquisite tastes of living in the evening, the first innovation is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination with a low color temperature which is necessary for creating a soft and aesthetic night scene for the outdoor living area (such soft and aesthetic night view is not achievable by the high level illumination however), the second innovation is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without

getting lost or encountering an accident, wherein when a motion intrusion is detected by the motion sensor the security light is instantly changed to perform a high level illumination mode with a high color temperature light which offers people a high visibility of the surrounding environment when needed. For the visibility of a surrounding environment the high color temperature light is the winner while for the creation of a soft and aesthetic night view there is no substitute for the low color temperature light. It is the innovation of the present invention to configure a life-style security light with a low color temperature LED load and a high color temperature LED load respectively activated by a photo sensor and a motion sensor to resemble the natural phenomenon of a sun light. These two innovative functions ideally implemented by the LED loads coupled with the motion sensor to increase illumination with a high visibility when people enters into the short detection area make the present invention a perfect life-style lighting solution for enjoying an exquisite taste of evening life.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A two-level LED security light comprising:

a light-emitting unit configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;

a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled light color temperature;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

an external control unit including at least a first external control device outputting at least one first external control signal;

wherein the loading and power control unit comprises at least a first controller and a switching circuitry, wherein the switching circuitry is composed of a first controllable switching device and a second controllable switching device, wherein the first controller is electrically and respectively coupled with the light sensing control unit, the motion sensing unit, the first controllable switching device, the second controllable switching device, and the first external control device;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit, wherein the power source is a DC power source configured in the power supply unit to output at least one DC power;

wherein the first LED load and the second LED load are connected in parallel and are respectively and electrically coupled to the first controllable switching device and the second controllable switching device of the switching circuitry;

wherein the first controller outputs control signals to respectively control a first conduction rate of the first controllable switching device and a second conduction rate of the second controllable switching device to perform different illumination modes of the two-level LED security light characterized by different light intensities and different mingled light color temperatures according to signals respectively received from the light sensing control unit, the motion sensing unit and the first external control device;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit manages to deliver a low level electric power to the light-emitting unit to perform a low level illumination mode emitting light with a low light intensity and a first mingled light color temperature; wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to switch off the light-emitting unit; wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to deliver a high level electric power to the light-emitting unit to perform a high level illumination mode emitting light with a high light intensity and a second mingled light color temperature for a predetermined time duration before switching back to the low level illumination mode;

wherein the first external control device generates the at least one first external control signal for tuning and setting the first mingled light color temperature of the low level illumination mode or for tuning and setting the second mingled light color temperature of the high level illumination mode;

wherein the LEDs of the first LED load and the LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the DC power source an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED, wherein V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

2. The two-level LED security light according to claim **1**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the first LED load or the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

3. The two-level LED security light according to claim **2**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltages imposed on the first LED load and the second LED load respectively represented by V_N and V_M are confined in domains expressed by N×2.5 volts$<V_N<$N×3.5 volts and M×2.5 volts$<V_M<$M×3.5 volts, wherein N and M are positive integrals denoting respective numbers of series connected LEDs in the first LED load and the second LED load.

4. The two-level LED security light according to claim **1**, wherein the first controllable switching device comprises at

least one first semiconductor switching device working in conjunction with the first controller to control the first conduction rate of the first controllable switching device; wherein the second controllable switching device comprises at least one second semiconductor switching device working in conjunction with the first controller to control the second conduction rate of the second controllable switching device.

5. The two-level LED security light according to claim **1**, wherein the first controllable switching device is a first LED driver outputting a first electric power delivered to the first LED load; wherein the second controllable switching device is a second LED driver outputting a second electric power to the second LED load.

6. The two-level LED security light according to claim **1**, wherein when the light-emitting unit is operated in the low level illumination mode, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable to tune the first mingled light color temperature of the diffused light created thru the light diffuser; wherein upon receiving the at least one first external control signal from the first external control device the first controller operates in response to reversely and complementarily adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for tuning to a lower mingled light color temperature, the first controller upon receiving the at least one first external control signal operates to control the switching circuitry to increase a first electric power delivered to the first LED load and at the same time to decrease a second electric power delivered to the second LED load such that a sum of the first electric power and the second electric power remains essentially unchanged; wherein for tuning to a higher mingled light color temperature, the first controller upon receiving the at least one first external control signal operates to control the switching circuitry to decrease the first electric power delivered to the first LED load and at the same time to increase the second electric power delivered to the second LED load such that a sum of the first electric power and the second electric power remains essentially unchanged and is equal to the low level electric power in the low level illumination mode.

7. The two-level LED security light according to claim **1**, wherein when the light-emitting unit is operated in the high level illumination mode, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable to tune the second mingled light color temperature of the diffused light created thru the light diffuser; wherein upon receiving the at least one first external control signal from the first external control device the first controller operates in response to reversely and complementarily adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for tuning to a lower mingled light color temperature, the first controller upon receiving the at least one first external control signal operates to control the switching circuitry to increase a first electric power delivered to the first LED load and at the same time to decrease a second electric power delivered to the second LED load such that a sum of the first electric power and the second electric power remains essentially unchanged; wherein for tuning to a higher mingled light color temperature, the first controller upon receiving the at least one first external control signal operates to control the switching circuitry to decrease the first electric power delivered to the first LED load and at the same time to increase the second electric power delivered to the second LED load such that the sum of the first electric power and the second electric power remains essentially unchanged and is equal to the high level electric power in the high level illumination mode.

8. The two-level LED security light according to claim **1**, wherein when the light-emitting unit is in a conduction state, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable, wherein the first controller in response to the at least one first external control signal received respectively outputs a first PWM signal to control the first conduction rate of the first controllable switching device and a second PWM signal to control the second conduction rate of the second controllable switching device with an arrangement that the first conduction rate of the first controllable switching device and the second conduction rate of the second controllable switching device are reversely adjusted such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load is maintained essentially at a constant level while the mingled light color temperature of the light emitted by the first LED load and the light emitted by the second LED load thru the light diffuser is proportionately adjusted according to the at least one first external control signal to perform a color temperature tuning of the first mingled light color temperature of the low level illumination or the second mingled light color temperature of the high level illumination.

9. The two-level LED security light according to claim **8**, wherein the first external control device includes a voltage divider, wherein the voltage divider is configured to output at least one voltage signal with a voltage value, wherein the at least one voltage signal with a voltage value is the at least one first external control signal, wherein upon receiving the at least one first external control signal the first controller operates to perform a corresponding mingled light color temperature according to the voltage value of the at least one voltage signal generated by the voltage divider.

10. The two-level LED security light according to claim **1**, wherein the first controller is programmed to operate with at least one color temperature switching scheme comprising a plurality of different mingled light color temperature tuning processes for tuning and selecting the first mingled light color temperature of the low level illumination mode or for tuning and selecting the second mingled light color temperature of the high level illumination mode, wherein paired combinations of the first conduction rate of the first controllable switching device and the second conduction rate of the second controllable switching device for respectively controlling a first electric power delivered to the first LED load and a second electric power delivered to the second LED load for creating different mingled light color temperatures are preprogrammed for operating a pick and play process according to the at least one first external control signal received and interpreted by the first controller for performing a selected mingled light color temperature; wherein in programming the paired combinations of different conduction rates of the switching circuitry, the first electric power delivered to the first LED load and the second electric power delivered to the second LED load are complementarily and reversely adjusted such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remains essentially unchanged.

11. The two-level LED security light according to claim **10**, wherein the first external control device includes a voltage divider, wherein the voltage divider is configured to output at least one voltage signal with a voltage value, wherein the first controller operates the pick and play process to activate a corresponding mingled light color

temperature tuning process in the at least one color temperature switching scheme according to the voltage value of the at least one voltage signal outputted by the voltage divider.

12. The two-level LED security light according to claim **11**, wherein the voltage divider is designed with a step-less/free setting switch, wherein the voltage divider is configured to operate with a variable resistor to output a voltage value corresponding to a final parking location of a switching motion of the step-less/free setting switch on the variable resistor; wherein a full range of the voltage value outputted by the voltage divider corresponding to a full length of the variable resistor is divided into a plurality of different voltage domains for respectively activating the pick and play process, wherein the step-less/free setting switch is allowed to park at any location on the variable resistor to generate a corresponding voltage value to the first controller, wherein the first controller is designed to operate the pick and play process according to a belonging of a voltage domain with respect to the corresponding voltage value received from the voltage divider for selecting and activating a corresponding mingled light color temperature tuning process in the at least one color temperature switching scheme corresponding to the voltage domain.

13. The two-level LED security light according to claim **10**, wherein the first external control device includes a selection switch configured with a plurality of switching positions with each of the plurality of switching positions respectively for activating a corresponding process in the first controller, wherein when a switching position is operated by the selection switch, a corresponding mingled light color temperature switching process is activated to perform a corresponding mingled light color temperature.

14. The two-level LED security light according to claim **13**, wherein the selection switch is a slide switch, a rotary switch, a pull chain switch or any switch design having a capacity to perform the same selection function.

15. The two-level LED security light according to claim **10**, wherein the first external control device includes at least one push button or one touch pad and the at least one external control signal is a voltage signal generated by operating the push button or the touch pad, wherein upon receiving the voltage signal the first controller operates the pick and play process to alternately perform the selected mingled light color temperature in the at least one color temperature switching scheme according to a preset sequence.

16. The two-level LED security light according to claim **10**, wherein the first external control device includes at least one wireless signal receiver to receive a wireless external control signal from a mobile device, a smart phone or a smart speaker for activating the pick and play process for selecting a corresponding mingled light color temperature tuning process in the at least one color temperature switching scheme for performing a corresponding first mingled light color temperature or a corresponding second mingled light color temperature.

17. The two-level LED security light according to claim **10**, wherein the first external control device is a power interruption detection circuitry electrically coupled to the first controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the first controller operates to alternately switch a selection of different mingled light color temperatures according to the at least one color temperature switching scheme preprogrammed.

18. The two-level LED security light according to claim **1**, wherein each of the first controllable switching device and the second controllable switching device comprises at least one uni-directional semiconductor switching element, wherein the uni-directional switching elements are bipolar junction transistors (BJTs) or metal-oxide-semiconductor field-effect transistors (MOSFETs).

19. A lifestyle LED security light comprising:

a light-emitting unit, configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;

a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled light color temperature;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

an external control unit including at least a first external control device outputting at least one first external control signal;

wherein the loading and power control unit comprises at least a first controller and a switching circuitry, wherein the first controller is electrically and respectively coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the first external control device; wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit, wherein the power source is a DC power source configured in the power supply unit to output at least one DC power; wherein the switching circuitry comprises at least a first controllable switching device and at least a second controllable switching device; wherein the first LED load and the second LED load are connected in parallel and are further respectively and electrically coupled to the first controllable switching device and the second controllable switching device; wherein the first controller outputs a first control signal to control a first conduction rate of the first controllable switching device for delivering a first electric power to the first LED load and simultaneously a second control signal to control a second conduction rate of the second controllable switching device for delivering a second electric power to the second LED load such that the light-emitting unit respectively generates illuminations of different light intensities and different mingled light color temperatures for performing different illumination modes according to signals respectively received from the light sensing control unit, the motion sensing unit and the first external control device; wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit manages to deliver an electric power to the light-emitting unit to perform a first illumination mode with a first level illumination characterized by a first light intensity and a first mingled light color temperature for a first predetermined time duration with the motion sensing unit being temporarily deactivated; wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to cutoff the electric power delivered to the light-emitting unit and at the same time the motion sensing unit is activated; wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to deliver

the electric power to the light-emitting unit to perform a second illumination mode with a second level illumination characterized by a second light intensity and a second mingled light color temperature for a second predetermined time duration before being switched back to a turned off state; wherein the second light intensity of the second level illumination is equal to or higher than the first light intensity of the first level illumination; wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to switch off the light-emitting unit;

wherein the first external control device generates the at least one first external control signal for tuning and setting the first mingled light color temperature of the first illumination mode or for tuning and setting the second mingled light color temperature of the second illumination mode;

wherein the LEDs of the first LED load and the LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the DC power source of the power supply unit an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of V_{th}<V<V_{max} featuring electrical characteristics of the LED chip, wherein V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

20. The lifestyle LED security light according to claim **19**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the first LED load or the second LED load is confined in a domain between a minimum voltage equal to a sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

21. The lifestyle LED security light according to claim **20**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts<V_{th}<V<V_{max}<3.5 volts and the working voltages imposed on the first LED load and the second LED load respectively represented by V_N and V_M are confined in domains expressed by N×2.5 volts<V_N<N×3.5 volts and M×2.5 volts<V_M<M×3.5 volts, wherein N and M are positive integrals denoting respective numbers of series connected LEDs in the first LED load and in the second LED load.

22. The lifestyle LED security light according to claim **19**, wherein the first controllable switching device comprises at least one first semiconductor switching device working in conjunction with the first controller to control the first conduction rate of the first controllable switching device; wherein the second controllable switching device comprises at least one second semiconductor switching device working in conjunction with the first controller to control the second conduction rate of the second controllable switching device.

23. The lifestyle LED security light according to claim **19**, wherein the first controllable switching device is a first LED driver outputting the first electric power delivered to the first LED load; wherein the second controllable switching device is a second LED driver outputting the second electric power delivered to the second LED load.

24. The lifestyle LED security light according to claim **19**, wherein the first mingled light color temperature of the first level illumination in performing the first illumination mode is the low color temperature, wherein the second controllable switching device is in a cutoff state and the first controller outputs only the first control signal to control the first conduction rate of the first controllable switching device to deliver the electric power to the light-emitting unit to determine the light intensity of the first illumination mode.

25. The lifestyle LED security light according to claim **19**, wherein the second mingled light color temperature of the second level illumination in performing the second illumination mode is the high color temperature, wherein the first controllable switching device is in a cutoff state and the first controller outputs only the second control signal to control the second conduction rate of the second controllable switching device to deliver the electric power to the light-emitting unit to determine the light intensity of the second illumination mode.

26. The lifestyle LED security light according to claim **19**, wherein when the light-emitting unit is in the first illumination mode, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable to tune the mingled light color temperature of the diffused light created thru the light diffuser; wherein upon receiving the at least one first external control signal from the first external control device the first controller operates to reversely and complementarily adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remains essentially unchanged; wherein for tuning to a lower mingled light color temperature, the first controller upon receiving the external control signal operates to control the first controllable switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the second controllable switching device to proportionally decrease the second electric power delivered to the second LED load; wherein for tuning to a higher mingled light color temperature, the first controller upon receiving the external control signal operates to control the first controllable switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the second controllable switching device to proportionally increase the second electric power delivered to the second LED load.

27. The lifestyle LED security light according to claim **19**, wherein when the light-emitting unit is in the second illumination mode, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable to tune the mingled light color temperature of the diffused light created thru the light diffuser; wherein upon receiving the at least one first external control signal from the first external control device the first controller operates to reversely and complementarily adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remains essentially unchanged; wherein for tuning to a lower mingled light

color temperature, the first controller upon receiving the at least one first external control signal operates to control the first controllable switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the second controllable switching device to proportionally decrease the second electric power delivered to the second LED load; wherein for tuning to a higher mingled light color temperature, the first controller upon receiving the at least one first external control signal operates to control the first controllable switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the second controllable switching device to proportionally increase the second electric power delivered to the second LED load.

28. The lifestyle LED security light according to claim **19**, wherein when the light-emitting unit is in a conduction state, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable, wherein the first controller in response to the at least one first external control signal received respectively outputs a first PWM signal to control the first conduction rate of the first controllable switching device and a second PWM signal to control the second conduction rate of the second controllable switching device with an arrangement that the first conduction rate of the first controllable switching device and the second conduction rate of the second controllable switching device are reversely adjusted such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load is maintained essentially at a constant level while the mingled light color temperature of the light emitted by the first LED load and the light emitted by the second LED load thru the light diffuser is proportionately adjusted according to the at least one first external control signal to perform a color temperature tuning of the first mingled light color temperature of the low level illumination or the second mingled light color temperature of the high level illumination.

29. The lifestyle LED security light according to claim **28**, wherein the first external control device includes a voltage divider, wherein the voltage divider is configured to output at least one voltage signal with a voltage value, wherein the at least one voltage signal with a voltage value is the at least one first external control signal, wherein upon receiving the at least one first external control signal the first controller operates to perform a corresponding mingled light color temperature according to the voltage value of the at least one voltage signal generated by the voltage divider.

30. The lifestyle LED security light according to claim **19**, wherein the first controller is programmed to operate with at least one color temperature switching scheme comprising a plurality of different mingled light color temperature tuning processes for tuning and selecting the first mingled light color temperature of the first illumination mode or for tuning and setting the second mingled light color temperature of the second illumination mode, wherein paired combinations of the first conduction rate of the first controllable switching device and the second conduction rate of the second controllable switching device for respectively controlling the first electric power delivered to the first LED load and the second electric power delivered to the second LED load for creating different mingled light color temperatures are preprogrammed for operating a pick and play process according to the at least one first external control signal received and interpreted by the first controller for performing a selected mingled light color temperature; wherein in programming the paired combinations of different conduction rates of the switching circuitry, the first electric power delivered to the first LED load and the second electric power delivered to the second LED load are complementarily and reversely adjusted such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remains essentially unchanged.

31. The lifestyle LED security light according to claim **30**, wherein the first external control device includes a voltage divider, wherein the voltage divider is configured to output at least one voltage signal with a voltage value, wherein upon receiving the at least one first external control signal the first controller operates the pick and play process to activate a corresponding mingled light color temperature process in the at least one color temperature switching scheme according to the voltage value of the at least one voltage signal outputted by the voltage divider.

32. The lifestyle LED security light according to claim **31**, wherein the voltage divider is designed with a step-less/free setting switch, wherein the voltage divider is configured to operate with a variable resistor to output a voltage value corresponding to a final parking location of a switching motion of the step-less/free setting switch on the variable resistor; wherein a full range of the voltage value outputted by the voltage divider corresponding to a full length of the variable resistor is divided into a plurality of different voltage domains for respectively activating the pick and play process, wherein the step-less/free setting switch is allowed to park at any location on the variable resistor to generate a corresponding voltage value to the first controller, wherein the first controller is designed to operate the pick and play process according to a belonging of a voltage domain with respect to the corresponding voltage value received from the voltage divider for selecting and activating a corresponding mingled light color temperature tuning process in the at least one color temperature switching scheme corresponding to the voltage domain.

33. The lifestyle LED security light according to claim **30**, wherein the first external control device includes at least one push button or one touch pad and the at least one external control signal is a voltage signal generated by operating the push button or the touch pad, wherein upon receiving the voltage signal the first controller operates the pick and play process to alternately perform the selected mingled light color temperature in the at least one color temperature switching scheme according to a preset sequence.

34. The lifestyle LED security light according to claim **30**, wherein the first external control device includes a selection switch configured with a plurality of switching positions with each of the plurality of switching positions respectively for activating a corresponding process in the first controller, wherein when a switching position is operated by the selection switch, a corresponding mingled light color temperature switching process is activated to perform a corresponding mingled light color temperature.

35. The lifestyle LED security light according to claim **34**, wherein the selection switch is a slide switch, a rotary switch, a pull chain switch or any switch design having a capacity to perform the same selection function.

36. The lifestyle LED security light according to claim **30**, wherein the first external control device includes a power interruption detection circuitry electrically coupled to the first controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the first controller operates to alternately switch a selection of different mingled light color temperatures according to the at least one color temperature switching scheme preprogrammed.

37. The lifestyle LED security light according to claim **30**, wherein the first external control device includes at least one wireless signal receiver to receive a wireless external control signal from a mobile device, a smart phone or a smart speaker and to convert the wireless external control signal into a message carrying sensing signal interpretable and executable by the first controller for activating the pick and play process for selecting a corresponding mingled light color temperature tuning process in the at least one color temperature switching scheme for performing a corresponding first mingled light color temperature or a corresponding second mingled light color temperature.

38. The lifestyle LED security light according to claim **19**, wherein each of the first controllable switching device and the second controllable switching device comprises at least one uni-directional semiconductor switching element, wherein the uni-directional switching elements are bipolar junction transistors (BJTs) or metal-oxide-semiconductor field-effect transistors (MOSFETs).

39. A lifestyle LED security light comprising:

a light-emitting unit, configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;

a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled light color temperature;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

an external control unit including at least a first external control device outputting at least one first external control signal;

wherein the loading and power control unit comprises at least a first controller and a switching circuitry, wherein the first controller is electrically and respectively coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the first external control device; wherein the switching circuitry is electrically coupled between at least one power source of the power supply unit and the light-emitting unit, wherein the at least one power source is a DC power source configured in the power supply unit to output at least one DC power; wherein the switching circuitry comprises at least a first controllable switching device and a second controllable switching device; wherein the first LED load and the second LED load are connected in parallel and are further respectively and electrically coupled to the first controllable switching device and the second controllable switching device; wherein the first controller outputs a first control signal to control a first conduction rate of the first controllable switching device for delivering a first electric power to the first LED load and simultaneously the first controller also outputs a second control signal to control a second conduction rate of the second controllable switching device for delivering a second electric power to the second LED load such that the light-emitting unit respectively generates illuminations of different light intensities and different mingled light color temperatures for performing different illumination modes according to signals respectively received from the light sensing control unit, the motion sensing unit and the first external control device;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit manages to deliver an electric power to the light-emitting unit to perform a first illumination mode with a first level illumination characterized by a first light intensity and a first mingled light color temperature for a first predetermined time duration with the motion sensing unit being temporarily deactivated; wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to reduce the electric power delivered to the light-emitting unit to generate a low level illumination characterized by a low light intensity and at the same time the motion sensing unit is activated; wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to increase the electric power delivered to light-emitting unit to perform a second illumination mode with a second level illumination characterized by a second light intensity and a second mingled light color temperature for a second predetermined time duration before being switched back to the low level illumination, wherein the second light intensity of the second level illumination is equal to or higher than the first light intensity of the first level illumination, wherein the first light intensity of the first level illumination is equal to or higher than the low light intensity of the low level illumination; wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to switch off the light-emitting unit;

wherein the first external control device generates the at least one first external control signal for tuning the first mingled light color temperature of the first illumination mode or for tuning the second mingled light color temperature of the second illumination mode;

wherein the LEDs of the first LED load and the LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the DC power source of the power supply unit an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, wherein V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

40. The lifestyle LED security light according to claim **39**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the first LED load or the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

41. The lifestyle LED security light according to claim **40**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltages imposed on the first LED load and the second LED load

respectively represented by V_N and V_M are confined in domains expressed by N×2.5 volts<V_N<N×3.5 volts and M×2.5 volts<V_M<M×3.5 volts, wherein N and M are positive integrals denoting respective numbers of series connected LEDs in the first LED load and the second LED load.

42. The lifestyle LED security light according to claim **39**, wherein the first controllable switching device comprises at least one first semiconductor switching device working in conjunction with the first controller to control the first conduction rate of the first controllable switching device; wherein the second controllable switching device comprises at least one second semiconductor switching device working in conjunction with the first controller to control the second conduction rate of the second controllable switching device.

43. The lifestyle LED security light according to claim **39**, wherein the first controllable switching device is a first LED driver outputting the first electric power delivered to the first LED load; wherein the second controllable switching device is a second LED driver outputting the second electric power to the second LED load.

44. The lifestyle LED security light according to claim **39**, wherein the first mingled light color temperature in performing the first illumination mode is the low color temperature, wherein the second controllable switching device is in a cutoff state and the first controller outputs only the first control signal to control the first conduction rate of the first controllable switching device to deliver the electric power to the light-emitting unit to determine the light intensity and the first mingled light color temperature of the first illumination mode.

45. The lifestyle LED security light according to claim **39**, wherein the second mingled light color temperature in performing the second illumination mode is the high color temperature, wherein the first controllable switching device is in a cutoff state and the first controller outputs only the second control signal to control the second conduction rate of the second controllable switching device to deliver the electric power to the light-emitting unit to determine the light intensity and the second mingled light color temperature of the second illumination mode.

46. The lifestyle LED security light according to claim **39**, wherein when the light-emitting unit is in a conduction state, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable, wherein the first controller in response to the at least one first external control signal received respectively outputs a first PWM signal to control the first conduction rate of the first controllable switching device and a second PWM signal to control the second conduction rate of the second controllable switching device with an arrangement that the first conduction rate of the first controllable switching device and the second conduction rate of the second controllable switching device are reversely adjusted such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load is maintained essentially at a constant level while the mingled light color temperature of the light emitted by the first LED load and the light emitted by the second LED load thru the light diffuser is proportionately adjusted according to the at least one first external control signal to perform a color temperature tuning of the first mingled light color temperature of the low level illumination or the second mingled light color temperature of the high level illumination.

47. The lifestyle LED security light according to claim **46**, wherein the first external control device includes a voltage divider, wherein the voltage divider is configured to output at least one voltage signal with a voltage value, wherein the at least one voltage signal with a voltage value is the at least one first external control signal, wherein upon receiving the at least one first external control signal the first controller operates to perform a corresponding mingled light color temperature according to the voltage value of the at least one voltage signal generated by the voltage divider.

48. The lifestyle LED security light according to claim **39**, wherein when the light-emitting unit is in the first illumination mode, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable to tune the first mingled light color temperature; wherein upon receiving the at least one first external control signal from the first external control device the first controller operates to reversely and complementarily adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remains essentially unchanged; wherein for tuning to a lower mingled light color temperature, the first controller upon receiving the at least one first external control signal from the first external control device operates to control the first controllable switching device to increase the first electric power delivered to the first LED load and at the same time proportionally decrease the second electric power delivered to the second LED load; wherein for tuning to a higher mingled light color temperature, the first controller upon receiving the at least one first external control signal from the first external control device operates to control the first controllable switching device to decrease the first electric power delivered to the first LED load and at the same time proportionally increase the second electric power delivered to the second LED load.

49. The lifestyle LED security light according to claim **39**, wherein when the light-emitting unit is in the second illumination mode, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable to tune the second mingled light color temperature; wherein upon receiving the at least one first external control signal from the first external control device the first controller operates to reversely and complementarily adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remains essentially unchanged; wherein for tuning to a lower mingled light color temperature, the first controller upon receiving the at least one first external control signal from the first external control device operates to control the first controllable switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the second controllable switching device to proportionally decrease the second electric power delivered to the second LED load; wherein for tuning to a higher mingled light color temperature, the first controller upon receiving the at least one first external control signal from the first external control device operates to control the first controllable switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the second controllable switching device to proportionally increase the second electric power delivered to the second LED load.

50. The lifestyle LED security light according to claim **39**, wherein the first controller is programmed to operate with at least one color temperature switching scheme comprising a plurality of different mingled light color temperature tuning processes for tuning and selecting the first mingled light

color temperature of the first illumination mode or for tuning and setting the second mingled light color temperature of the second illumination mode, wherein paired combinations of the first conduction rate of the first controllable switching device and the second conduction rate of the second controllable switching device for respectively controlling the first electric power delivered to the first LED load and the second electric power delivered to second LED load for creating different mingled light color temperatures are preprogrammed for operating a pick and play process according to the at least one first external control signal received and interpreted by the first controller for performing a selected mingled light color temperature; wherein in programming the paired combinations of different conduction rates of the switching circuitry, the first electric power delivered to the first LED load and the second electric power delivered to the second LED load are complementarily and reversely adjusted such that a total of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remains essentially unchanged.

51. The lifestyle LED security light according to claim **50**, wherein the first external control device includes a voltage divider, wherein the voltage divider is configured to output at least a voltage signal with a voltage value, wherein the first controller operates the pick and play process to activate a corresponding mingled light color temperature tuning process in the at least one color temperature switching scheme according to the voltage value of the at least one voltage signal outputted by the voltage divider.

52. The lifestyle LED security light according to claim **51**, wherein the voltage divider is designed with a step-less/free setting switch, wherein the voltage divider is configured to operate with a variable resistor to output a voltage value corresponding to a final parking location of a switching motion of the step-less/free setting switch on the variable resistor; wherein a full range of the voltage value outputted by the voltage divider corresponding to a full length of the variable resistor is divided into a plurality of different voltage domains for respectively activating the pick and play process, wherein the step-less/free setting switch is allowed to park at any location on the variable resistor to generate a corresponding voltage value to the first controller, wherein the first controller is designed to operate the pick and play process according to a belonging of a voltage domain with respect to the corresponding voltage value received from the voltage divider for selecting and activating a corresponding mingled light color temperature process in the at least one color temperature switching scheme corresponding to the voltage domain.

53. The lifestyle LED security light according to claim **50**, wherein the first external control device includes a push button or a touch pad and the at least one first external control signal is a voltage signal generated by operating the push button or the touch pad, wherein upon receiving the voltage signal the first controller operates the pick and play process to alternately perform the selected mingled light color temperature in the at least one color temperature switching scheme according to a preset sequence.

54. The lifestyle LED security light according to claim **50**, wherein the first external control device includes a selection switch configured with a plurality of switching positions with each of the plurality of switching positions respectively for activating a corresponding process in the first controller, wherein when a switching position is operated by the selection switch, a corresponding mingled light color temperature switching process is activated to perform a corresponding mingled light color temperature.

55. The lifestyle LED security light according to claim **54**, wherein the selection switch is a slide switch, a rotary switch, a pull chain switch or any switch design having a capacity to perform the same selection function.

56. The lifestyle LED security light according to claim **50**, wherein the first external control device includes a power interruption detection circuitry electrically coupled to the first controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the first controller operates to alternately switch a selection of different mingled light color temperatures according to the at least one color temperature switching scheme preprogrammed.

57. The lifestyle LED security light according to claim **50**, wherein the first external control device includes a wireless signal receiver to receive a wireless external control signal from a mobile device, a smart phone or a smart speaker and to convert the wireless external control signal into the at least one first external control signal interpretable and executable by the first controller for activating the pick and play process for selecting a corresponding mingled light color temperature tuning process in the at least one color temperature switching scheme for performing a corresponding first mingled light color temperature or a corresponding second mingled light color temperature.

58. The lifestyle LED security light according to claim **39** wherein each of the first controllable switching device and the second controllable switching device comprises at least one uni-directional semiconductor switching element, wherein the uni-directional switching elements are bipolar junction transistors (BJTs) or metal-oxide-semiconductor field-effect transistors (MOSFETs).

59. A two-level LED security light comprising:

a light-emitting unit configured with an LED load;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

an external control unit including at least a first external control device outputting at least one first external control signal;

wherein the LED load of the light-emitting unit includes a plurality of LEDs divided into two sets with a first set of N number LEDs and a second set of M number LEDs electrically connected in parallel, wherein N and M are positive integers, wherein the N number LEDs emits light with a low color temperature and the M number LEDs emits light with a high color temperature, wherein the first set of N number LEDs and the second set of M number LEDs are covered by a diffuser to create a diffused light with a mingled light color temperature;

wherein the loading and power control unit includes at least a first controller and a switching circuitry, wherein the switching circuitry is electrically coupled between a DC power source configured in the power supply unit and the light-emitting unit, wherein the switching circuitry comprises a first controllable switching device electrically coupled between the DC power source and the first set of N number LEDs and a second controllable switching device electrically coupled between the DC power source and the second set of M number LEDs;

wherein the first controller is electrically coupled with the light sensing control unit, the motion sensing unit, the

first controllable switching device, the second controllable switching device and at least the first external control device;

wherein the first controller outputs a first control signal to control a first conduction rate of the first controllable switching device for delivering a first electric power to the first set of N number LEDs and simultaneously the first controller also outputs a second control signal to control a second conduction rate of the second controllable switching device for delivering a second electric power to the second set of M number LEDs such that the light-emitting unit respectively generates illuminations of different light intensities and different mingled light color temperatures for performing different illuminations according to signals respectively received from the light sensing control unit, the motion sensing unit and at least the first external control device; wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to deliver a low level electric power to the light-emitting unit to generate a low level illumination characterized by a low light intensity and a first mingled light color temperature; wherein when the ambient light detected by the light sensing control unit is higher than the predetermined value, the loading and power control unit manages to switch off the light-emitting unit; wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to deliver a high level electric power to the light-emitting unit to generate a high level illumination characterized by a high light intensity and a second mingled light color temperature for a predetermined time duration before switching back to perform the low level illumination with the first mingled light color temperature;

wherein the first external control device generates the at least one first external control signal for tuning the first mingled light color temperature of the low level illumination or for tuning the second mingled light color temperature of the high level illumination;

wherein the plurality of LEDs of the first set of N number LEDs and the second set of M number LEDs in conjunction with a power level setting of the DC power source of the power supply unit are respectively designed with a configuration of in series and/or in parallel connections of LEDs such that an electric current passing through each LED of the light-emitting unit remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction.

60. The two-level LED security light according to claim **59**, wherein a total wattage of the M number LEDs is greater than a total wattage of the N number LEDs.

61. The two-level LED security light according to claim **59**, wherein a total wattage of the M number LEDs is equal to a total wattage of the N number LEDs.

62. The two-level LED security light according to claim **59**, wherein the first controllable switching device comprises at least one first semiconductor switching device working in conjunction with the first controller to control the first conduction rate of the first controllable switching device; wherein the second controllable switching device comprises at least one second semiconductor switching device working in conjunction with the first controller to control the second conduction rate of the second controllable switching device.

63. The two-level LED security light according to claim **59**, wherein the first controllable switching device is a first LED driver outputting the first electric power delivered to the first LED load; wherein the second controllable switching device is a second LED driver outputting the second electric power to the second LED load.

64. The two-level LED security light according to claim **59**, wherein when the two-level LED security light is operated to generate the low level illumination, the first mingled light color temperature is adjustable by the first controller, wherein the first controller in response to the at least one first external control signal outputs PWM signals to respectively control time lengths of conduction periods of the first controllable switching device and the second controllable switching device to vary in a reverse manner such that a light intensity of the first set of N number LEDs with the low color temperature and a light intensity of the second set of M number LEDs with the high color temperature are reversely adjusted with the same pace to produce a variable mingled light color temperature thru the light diffuser for performing a color temperature tuning of the low level illumination.

65. The two-level LED security light according to claim **59**, wherein when the two-level LED security light is operated to generate the high level illumination, the second mingled light color temperature of the high level illumination is further adjustable by the first controller, wherein the first controller in response to the at least one first external control signal outputs PWM signals to respectively control time lengths of conduction periods of the first controllable switching device and the second controllable switching device to vary in a reverse manner such that a light intensity of the first set of N number LEDs with the low color temperature and a light intensity of the second set of M number LEDs with the high color temperature are reversely adjusted with the same pace to produce a variable mingled light color temperature thru the light diffuser for performing a color temperature tuning of the high level illumination.

66. The two-level LED security light according to claim **59**, wherein when the light-emitting unit is in a conduction state, a light intensity of the N number LEDs and a light intensity of the M number LEDs are respectively adjustable, wherein the first controller in response to the at least one first external control signal received respectively outputs a first PWM signal to control the first conduction rate of the first controllable switching device and a second PWM signal to control the second conduction rate of the second controllable switching device with an arrangement that the first conduction rate of the first controllable switching device and the second conduction rate of the second controllable switching device are reversely adjusted such that a sum of the first electric power delivered to the N number LEDs and the second electric power delivered to the M number LEDs is maintained essentially at a constant level while the mingled light color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs thru the light diffuser is proportionately adjusted according to the at least one first external control signal to perform a color temperature tuning of the first mingled light color temperature of the low level illumination or the second mingled light color temperature of the high level illumination.

67. The two-level LED security light according to claim **66**, wherein the first external control device includes a

voltage divider, wherein the voltage divider is configured to output at least one voltage signal with a voltage value, wherein the at lead one voltage signal with a voltage value is the at least one first external control signal, wherein upon receiving the at least one first external control signal the first controller operates to perform a corresponding mingled light color temperature according to the voltage value of the at least one voltage signal generated by the voltage divider.

68. The two-level LED security light according to claim **59** wherein the first controller is programmed to operate with at least one color temperature switching scheme comprising a plurality of different mingled light color temperature tuning processes for tuning and selecting the first mingled light color temperature of the low level illumination or for tuning the second mingled light color temperature of the high level illumination, wherein paired combinations of a first conduction rate of the first controllable switching device and a second conduction rate of the second controllable switching device for respectively controlling a first electric power delivered to the first set of N number LEDs and a second electric power delivered to the second set of M number LEDs for creating different mingled light color temperatures are preprogrammed for operating a pick and play process according to the at least one first external control signal executable and interpretable by the first controller for performing a selected mingled light color temperature; wherein in programming the paired combinations of different conduction rates of the switching circuitry, the first electric power delivered to the first set of N number LEDs and the second electric power delivered to the second set of M number LEDs are complementarily and reversely adjusted such that a sum of the first electric power delivered to the first set of N number LEDs and the second electric power delivered to the second set of M number LEDs remains essentially unchanged.

69. The two-level LED security light according to claim **68**, wherein the first external control device includes voltage divider, wherein the voltage divider is configured to output at least one voltage signal with a voltage value, wherein the first controller operates the pick and play process to activate a corresponding mingled light color temperature tuning process in the at least one color temperature switching scheme according to the voltage value of the at least one voltage signal outputted by the voltage divider.

70. The two-level LED security light according to claim **69**, wherein the voltage divider is designed with a step-less/free setting switch, wherein the voltage divider is configured to operate with a variable resistor to output an analog signal with a voltage value corresponding to a final parking location of a switching motion of the step-less/free setting switch on the variable resistor; wherein a second controller is electrically coupled between the first external control device and the first controller, wherein the second controller comprises a detection device to convert the analog signal into a digital signal interpretable and executable by the first controller, wherein a full range of the voltage value outputted by the voltage divider corresponding to a full length of the variable resistor is divided into a plurality of different digital voltage domains respectively represented by a digital value for respectively activating the pick and play process, wherein the step-less/free setting switch is allowed to park at any location on the variable resistor to generate a corresponding voltage value of the at least one first external control signal to the second controller, wherein the second controller operates to output a digital signal to the first controller according to a belonging of a voltage domain with respect to the corresponding voltage value received from the voltage divider.

71. The two-level LED security light according to claim **69**, wherein the voltage divider is designed with a step-less/free setting switch, wherein the voltage divider is configured to operate with a variable resistor to output an analog signal with a voltage value corresponding to a final parking location of a switching motion of the step-less/free setting switch on the variable resistor; wherein the first controller is further designed to convert the analog signal from the voltage divider into an executable digital signal for activating the pick and play process, wherein a full range of the voltage value outputted by the voltage divider corresponding to a full length of the variable resistor is divided into a plurality of different digital voltage domains respectively represented by a digital value for respectively activating the pick and play process, wherein the step-less/free setting switch is allowed to park at any location on the variable resistor to generate a corresponding voltage value, wherein the corresponding voltage value is converted into a corresponding digital signal according to a belonging of a voltage domain with respect to the corresponding voltage value received from the voltage divider.

72. The two-level LED security light according to claim **68**, wherein the first external control device includes a selection switch configured with a plurality of switching positions with each of the plurality of switching positions respectively for activating a corresponding process in the first controller, wherein when a switching position is operated by the selection switch, a corresponding mingled light color temperature switching process is activated to perform a corresponding mingled light color temperature.

73. The two-level LED security light according to claim **72**, wherein the selection switch is a slide switch, a rotary switch, a pull chain switch or any switch design having a capacity to perform the same selection function.

74. The two-level LED security light according to claim **68**, wherein the first external control device includes at least one push button or one touch pad and the at least one external control signal is a voltage signal generated by operating the push button or the touch pad, wherein upon receiving the voltage signal the first controller operates the pick and play process to alternately perform the selected mingled light color temperature in the at least one color temperature switching scheme according to a preset sequence.

75. The two-level LED security light according to claim **68**, wherein the first external control device is a power interruption detection circuitry electrically coupled to the first controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the first controller operates to alternately switch a selection of different mingled light color temperatures according to the at least one color temperature switching scheme preprogrammed.

76. The two-level LED security light according to claim **68**, wherein the first external control device includes a wireless signal receiver to receive a wireless external control signal from a mobile device, a smart phone or a smart speaker and to convert the wireless external control signal into the at least one first external control signal interpretable and executable by the first controller for activating the pick and play process for selecting a corresponding mingled light color temperature tuning process in the at least one color temperature switching scheme for performing a correspond-

ing first mingled light color temperature performance or a corresponding second mingled light color temperature performance.

77. The two-level LED security light according to claim **59**, wherein when each of the first set of N number LEDs and the second set of M number LEDs is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first set of N number LEDs and the second set of the M number LEDs is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

78. The two-level LED security light according to claim **77**, wherein when the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the first set of N number LEDs and the second set of M number LEDs are required to operate with respective working voltages V_N and V_M confined in domains expressed by $N_s\times 2.5$ volts$<V_N<N_s\times 3.5$ volts and $M_s\times 2.5$ volts$<V_M<M_s\times 3.5$ volts, with N_s and M_s respectively denoting the numbers of series connected LEDs in the first set of N number LEDs and the second set of M number LEDs, wherein $N_s\leq N$ and $M_s\leq M$.

79. The two-level LED security light according to claim **56**, wherein each of the first controllable switching device and the second controllable switching device comprises at least one uni-directional semiconductor switching element, wherein the uni-directional switching elements are bipolar junction transistors (BJTs) or metal-oxide-semiconductor field-effect transistors (MOSFETs).

80. An LED lighting device configured with a running mingled light color temperature switching process of a color temperature switching scheme, comprising:

a light-emitting unit configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;

a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled light color temperature;

a mingled light color temperature tuning algorithm to generate the color temperature switching scheme comprising a plurality of different mingled light color temperature performances and to operate a running pick and play process of the plurality of different mingled light color temperature performances in the color temperature switching scheme by turns according to a prearranged sequence;

a loading and power control unit to execute each of the plurality of different mingled light color temperature performances by turns according to the prearranged sequence to implement the running mingled light color temperature switching process;

a power supply unit; and

at least a first external control device to output at least one first external control signal to activate the running mingled light color temperature switching process;

wherein the loading and power control unit comprises at least a first controller

and a switching circuitry, wherein the switching circuitry is composed of a first controllable switching device and a second controllable switching device,

wherein the first controller is electrically and respectively coupled with the first controllable switching device, the second controllable switching device, and the first external control device;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit, wherein the power source is a DC power source configured in the power supply unit to output at least one DC power;

wherein the first LED load and the second LED load are connected in parallel and are respectively and electrically coupled to the first controllable switching device and the second controllable switching device of the switching circuitry;

wherein the first controller outputs a first control signal to control a first conduction rate of the first controllable switching device and a second control signal to control a second conduction rate of the second controllable switching device to respectively deliver a first electric power to the first LED load and a second electric power to the second LED load to perform an illumination with a light intensity and a mingled light color temperature performance according to the at least one first external control signal received from at least the first external control device;

wherein the first controller is designed with the color temperature switching scheme comprising the plurality of different mingled light color temperature performances selectable for performing the mingled light color temperature of the light-emitting unit;

wherein each of the plurality of different diffused light color temperature performances is designed according to the mingled light color temperature tuning algorithm that the first conduction rate of the first controllable switching device and the second conduction rate of the second controllable switching device are reversely and complementarily adjusted such that a sum of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remains unchanged while the mingled light color temperature is changed to a lower color temperature performance or a higher color temperature performance;

wherein upon receiving the at least one first external control signal from the first external control device, the first controller operates a running pick and play process to continuously and recurrently perform each of the plurality of different mingled light color temperature performances by turns according to the prearranged sequence to implement the running mingled light color temperature switching process, the running mingled light color temperature switching process ceases at a time when the at least one first external control signal is terminated or a second external control signal is received by the first controller.

81. The LED lighting device configured with a running mingled light color temperature switching process of a color temperature switching scheme according to claim **80**, wherein the first external control device is a power detection device, wherein when a power on is detected, the first controller operates to activate the running mingled light color temperature switching process.

82. The LED lighting device configured with a running mingled light color temperature switching process of a color temperature switching scheme according to claim **80**, wherein the first external control device is a selection switch to activate or deactivate the running mingled light color temperature switching process.

83. The LED light device configured with a running mingled light color temperature switching process of a color temperature switching scheme according to claim **82**, wherein when the selection switch is operated to deactivate the running mingled light color temperature switching process, the first controller operates to terminate the running mingled light color temperature switching process with the mingled light color temperature being thereby determined for performing the diffused light of the light-emitting unit.

* * * * *

EXHIBIT H

US010770916B2

(12) **United States Patent**
Chen

(10) **Patent No.: US 10,770,916 B2**
(45) **Date of Patent: Sep. 8, 2020**

(54) **TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR**

(71) Applicant: **VAXCEL INTERNATIONAL CO., LTD.**, Carol Stream, IL (US)

(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

(73) Assignee: **Vaxcel International Co., Ltd.**, Carl Stream, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/668,599**

(22) Filed: **Oct. 30, 2019**

(65) **Prior Publication Data**

US 2020/0067343 A1 Feb. 27, 2020

Related U.S. Application Data

(60) Continuation of application No. 16/244,671, filed on Jan. 10, 2019, now Pat. No. 10,516,292, which is a (Continued)

(51) **Int. Cl.**
H05B 37/02 (2006.01)
H02J 7/35 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H02J 7/35*** (2013.01); ***F21S 9/03*** (2013.01); ***F21V 17/02*** (2013.01); ***G08B 5/36*** (2013.01); ***G08B 13/1895*** (2013.01); ***G08B 15/00*** (2013.01); ***G08B 15/002*** (2013.01); ***H05B 39/042*** (2013.01); ***H05B 39/044*** (2013.01); ***H05B 45/10*** (2020.01); ***H05B 45/14*** (2020.01); ***H05B 45/20*** (2020.01); ***H05B 45/37*** (2020.01); ***H05B 45/44*** (2020.01); ***H05B 45/46*** (2020.01); ***H05B 45/48*** (2020.01); ***H05B 47/10*** (2020.01); ***H05B 47/105*** (2020.01); ***H05B 47/11*** (2020.01); ***H05B 47/16*** (2020.01);
(Continued)

(58) **Field of Classification Search**
CPC H05B 33/0815; H05B 33/0824; H05B 33/083; H05B 33/0845; H05B 33/0854; H05B 33/0872; H05B 37/0218; H05B 37/0227; H05B 37/0281; H05B 37/0272
USPC 315/149, 152, 154, 307, 308, 312
See application file for complete search history.

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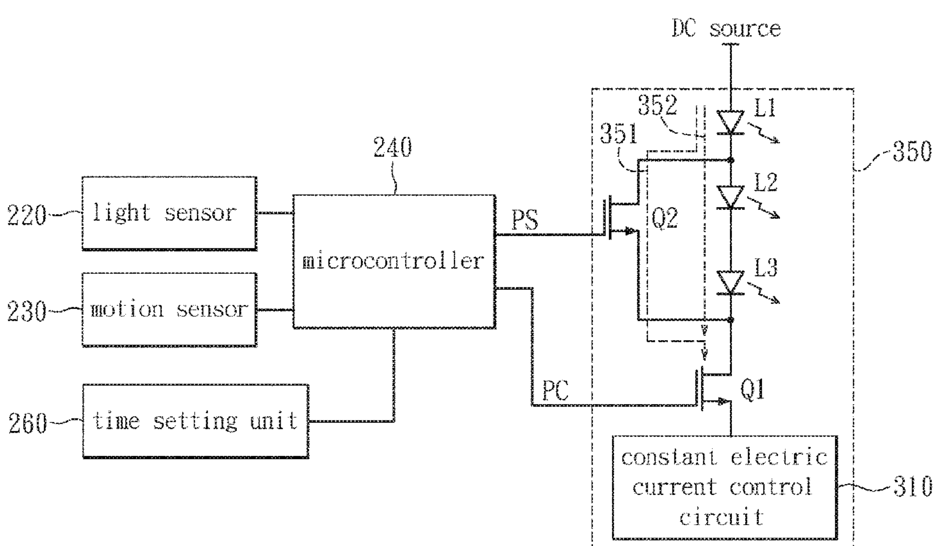
Primary Examiner — Tung X Le
(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A method of configuring an LED light with a tunable diffused light color temperature is disclosed. The method comprises using a light-emitting unit configured with a first LED load emitting light with a low color temperature and a second LED load emitting light with a high color temperature electrically connected in parallel, using a light diffuser to cover the first LED load and the second LED load to create a diffused light with a diffused light color temperature, using two semiconductor switching devices working in conjunction with a controller to respectively control a first electric power delivered to the first LED load and a second electric power delivered to the second LED load to operate a color temperature tuning and switching scheme and using a first external control device to output at least one first external control signal to activate a selection of a diffused light color temperature.

101 Claims, 18 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/896,403, filed on Feb. 14, 2018, now Pat. No. 10,225,902, which is a continuation of application No. 15/785,658, filed on Oct. 17, 2017, now Pat. No. 10,326,301, which is a continuation of application No. 15/375,777, filed on Dec. 12, 2016, now Pat. No. 9,826,590, which is a continuation of application No. 14/836,000, filed on Aug. 26, 2015, now Pat. No. 9,622,325, which is a division of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

(51) **Int. Cl.**

H05B 45/10	(2020.01)
H05B 45/14	(2020.01)
H05B 45/20	(2020.01)
H05B 45/37	(2020.01)
H05B 45/44	(2020.01)
H05B 45/46	(2020.01)
H05B 45/48	(2020.01)
H05B 47/10	(2020.01)
H05B 47/11	(2020.01)
H05B 47/16	(2020.01)
H05B 47/105	(2020.01)
G08B 15/00	(2006.01)
H05B 39/04	(2006.01)
F21S 9/03	(2006.01)
F21V 17/02	(2006.01)
G08B 5/36	(2006.01)
G08B 13/189	(2006.01)
F21Y 115/10	(2016.01)
G08B 13/00	(2006.01)

(52) **U.S. Cl.**

CPC *F21Y 2115/10* (2016.08); *G08B 13/00* (2013.01); *G08B 13/189* (2013.01); *Y02B 20/40* (2013.01); *Y02B 20/44* (2013.01); *Y02B 20/46* (2013.01)

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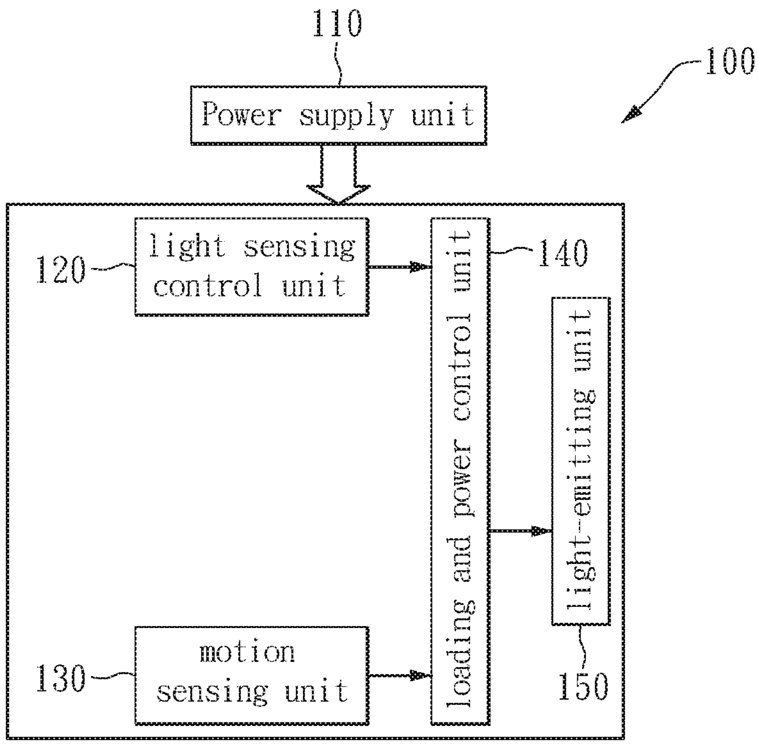

110
100
Power supply unit
120
light sensing control unit
140
loading and power control unit
light-emitting unit
130
motion sensing unit
150

FIG. 1

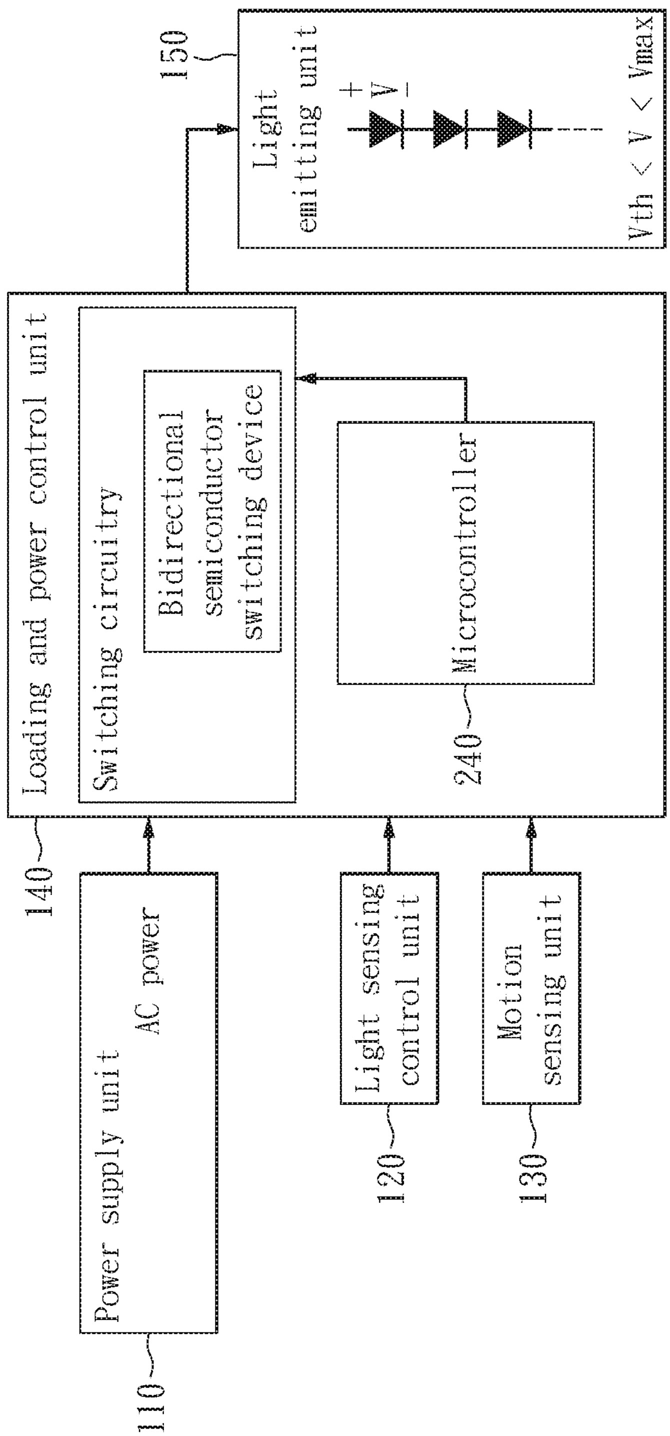

110
Power supply unit
AC power
120
Light sensing control unit
130
Motion sensing unit
140
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
240
Microcontroller
150
Light emitting unit
+ V −
Vth < V < Vmax

FIG. 1A

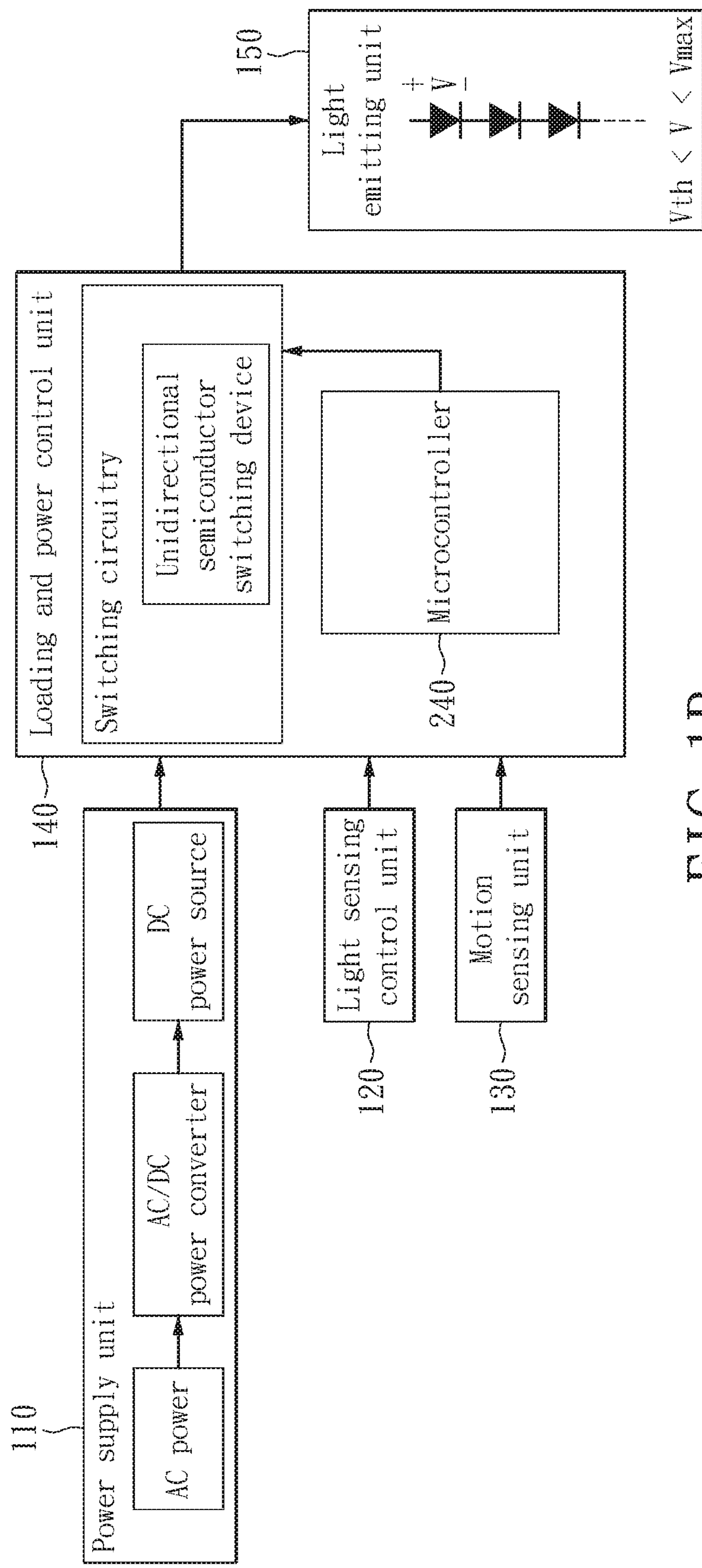

150
Light emitting unit
+ V −
Vth < V < Vmax
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
AC/DC power converter
DC power source
110
Light sensing control unit
120
Motion sensing unit
130

FIG. 1B

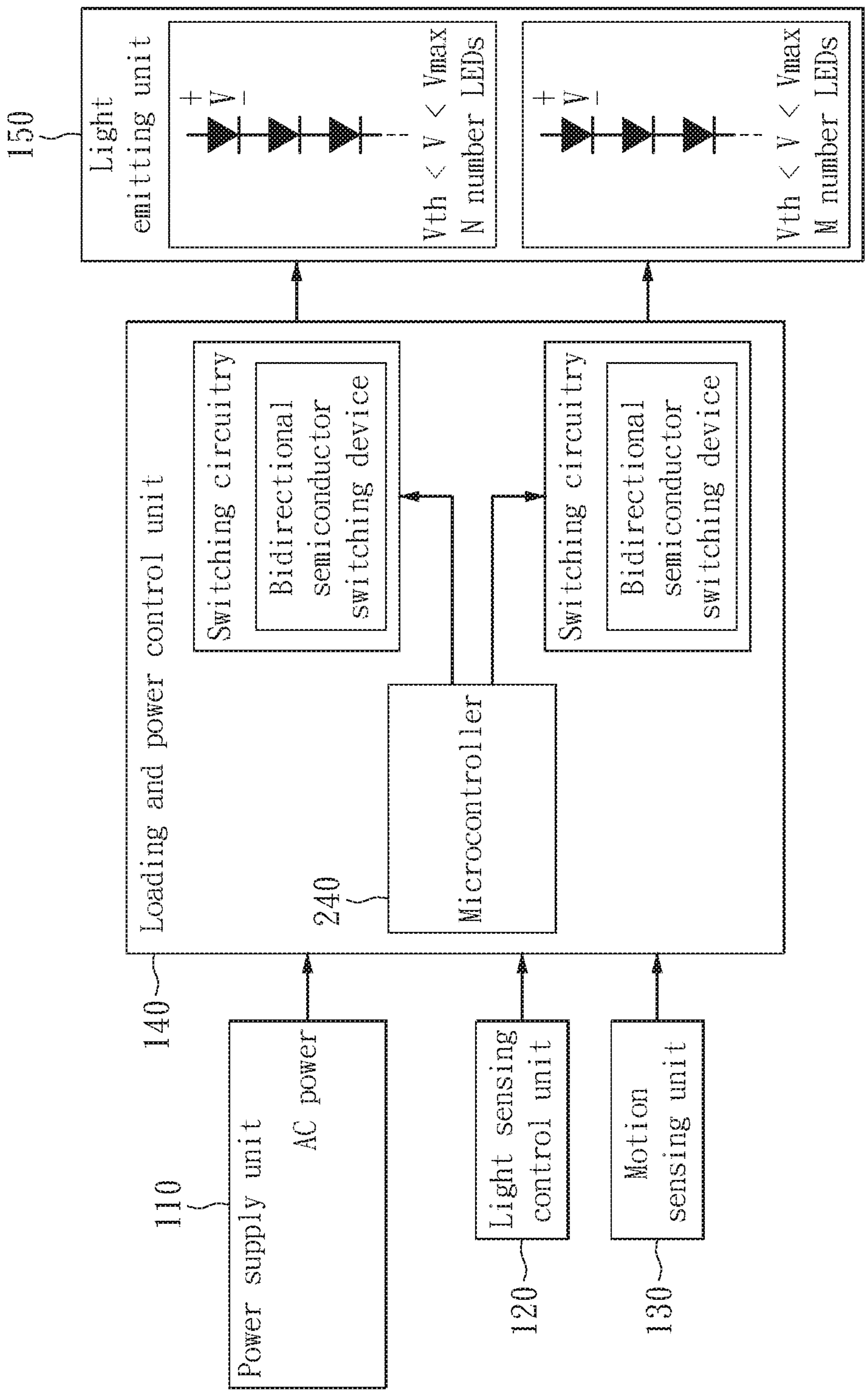

150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Switching circuitry
Bidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
Light sensing control unit
120
Motion sensing unit
130

FIG. 1C

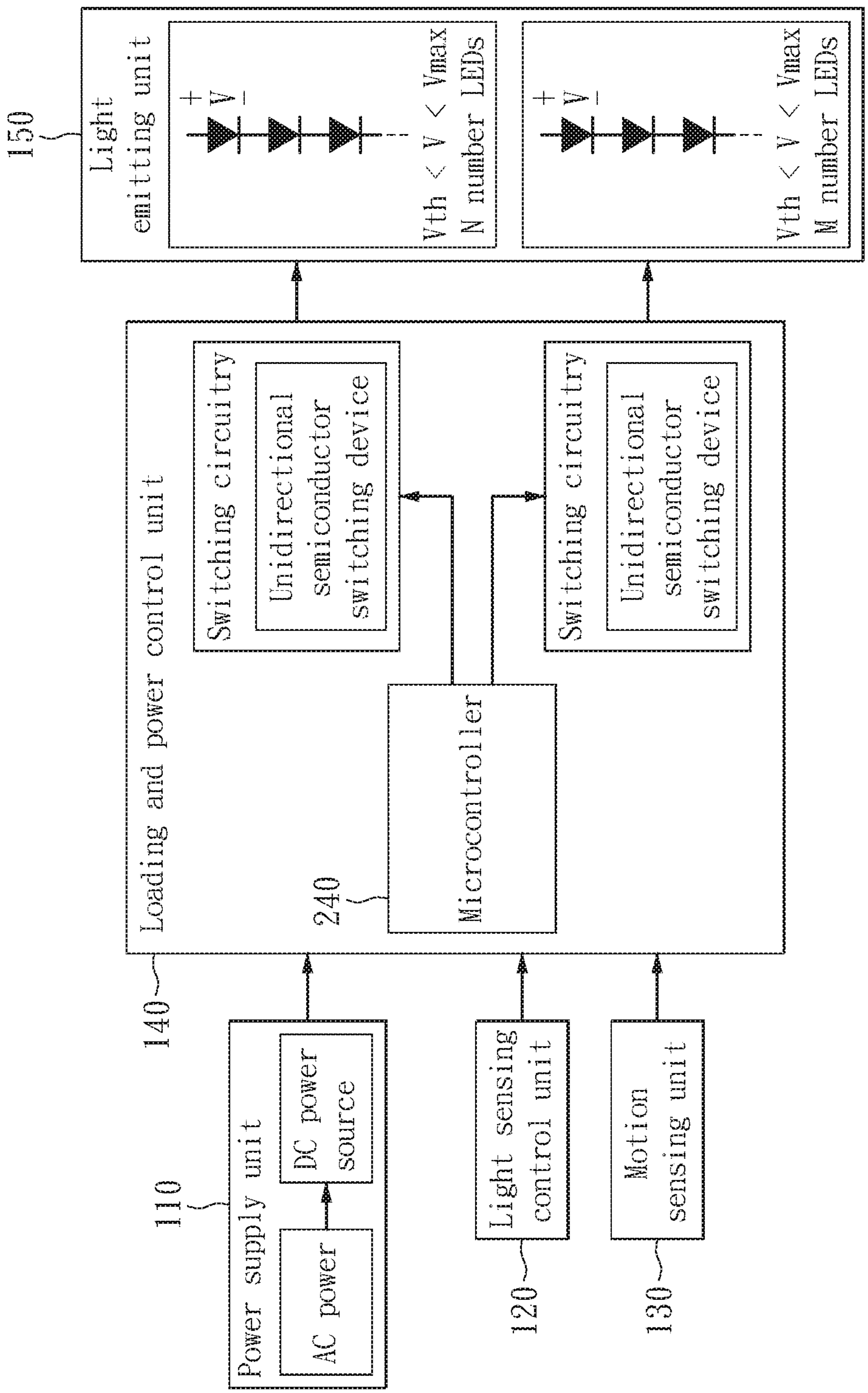

150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Switching circuitry
Unidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
DC power source
Light sensing control unit
120
Motion sensing unit
130

FIG. 1D

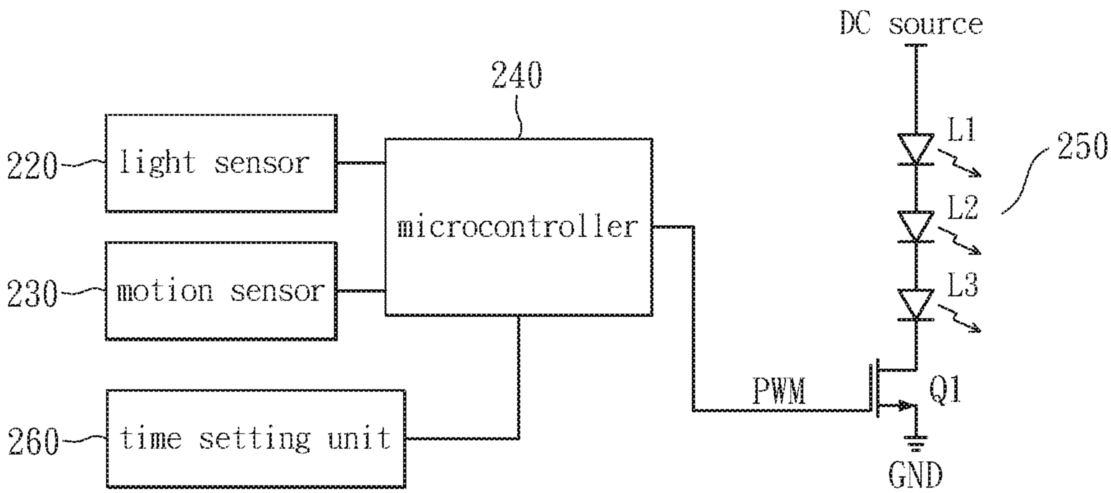

DC source
240
220
light sensor
microcontroller
230
motion sensor
260
time setting unit
L1
L2
L3
250
PWM
Q1
GND

FIG. 2A

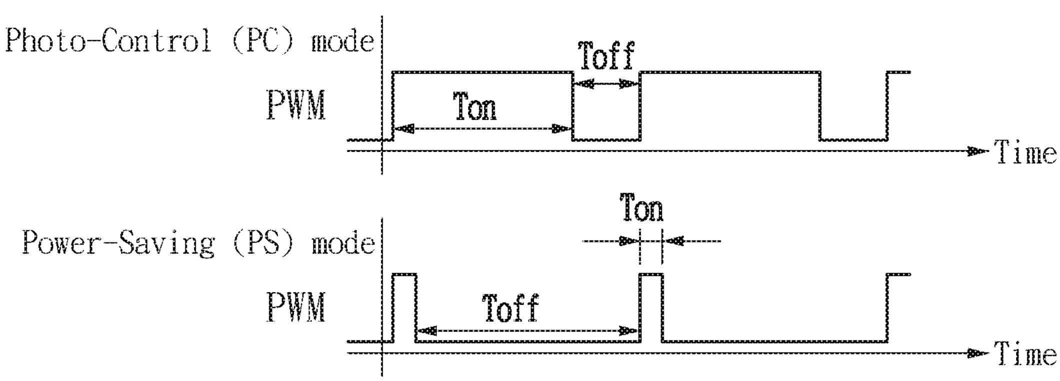
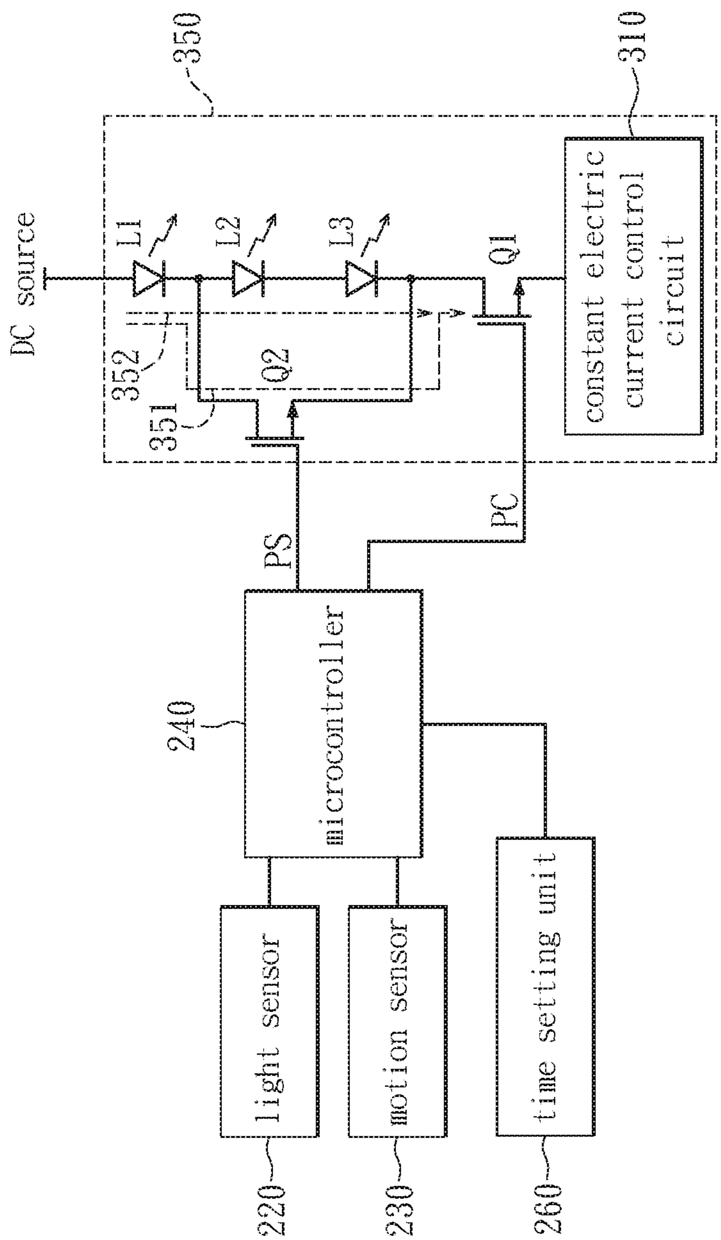


Photo-Control (PC) mode
PWM
Toff
Ton
Time
Power-Saving (PS) mode
Ton
PWM
Toff
Time

FIG. 2B



DC source
350
L1
L2
L3
Q1
352
351
Q2
310
constant electric current control circuit
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

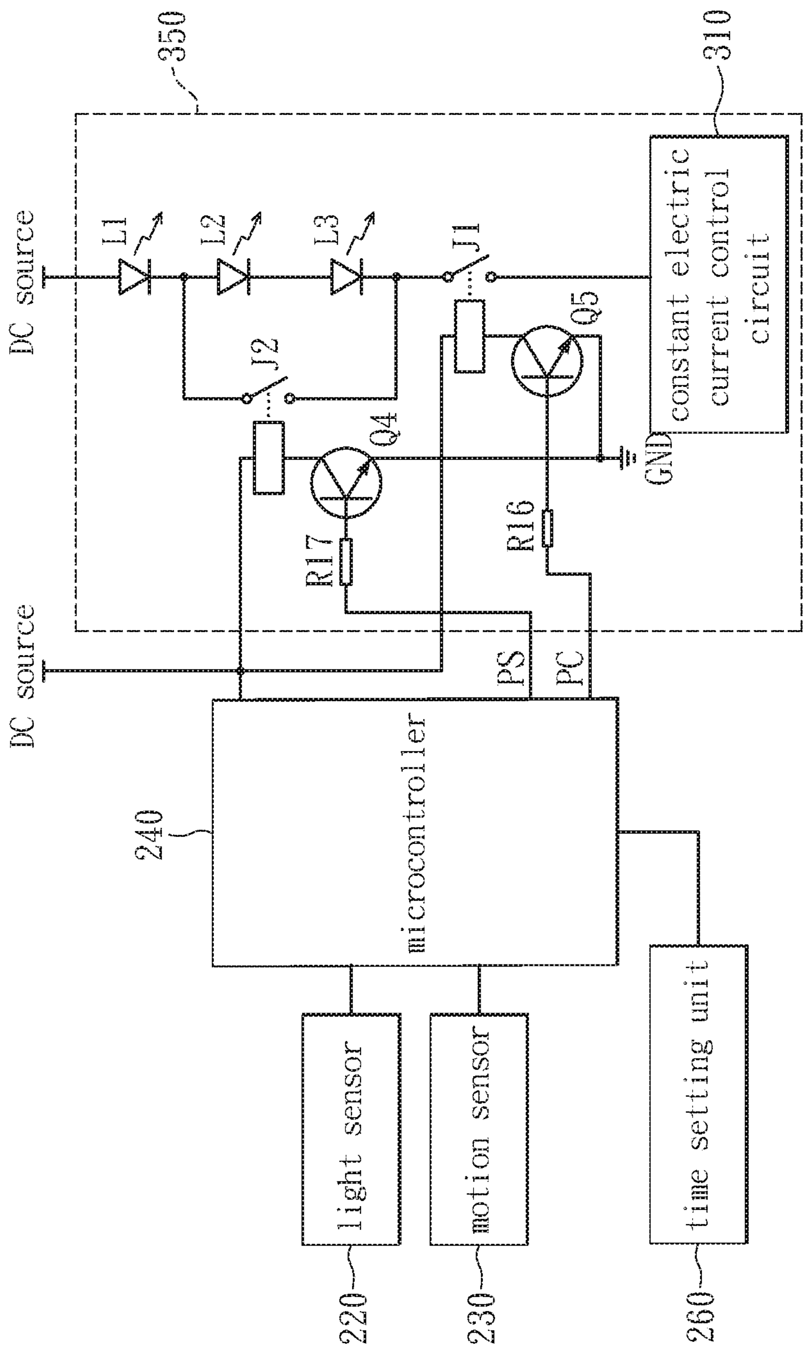

350
310
DC source
L1
L2
L3
J1
J2
Q4
Q5
constant electric current control circuit
GND
R16
R17
DC source
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

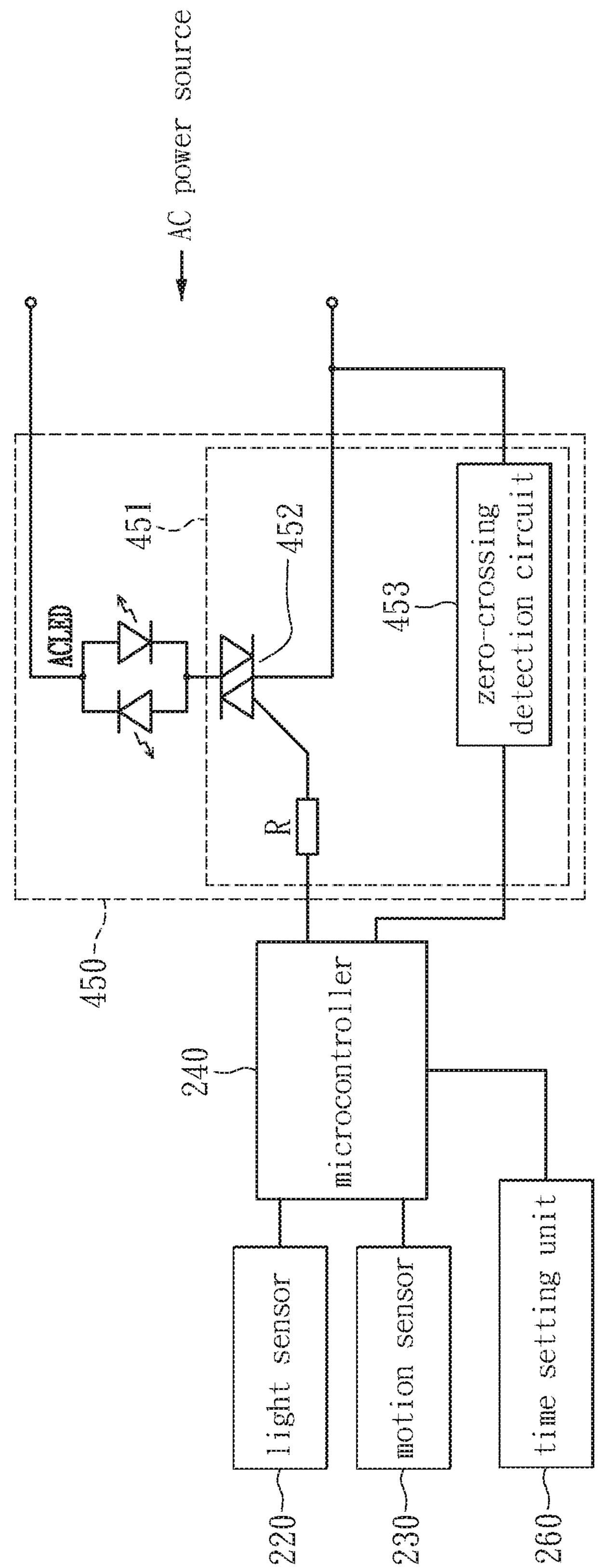

AC power source
451
452
453
ACLED
zero-crossing detection circuit
R
450
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

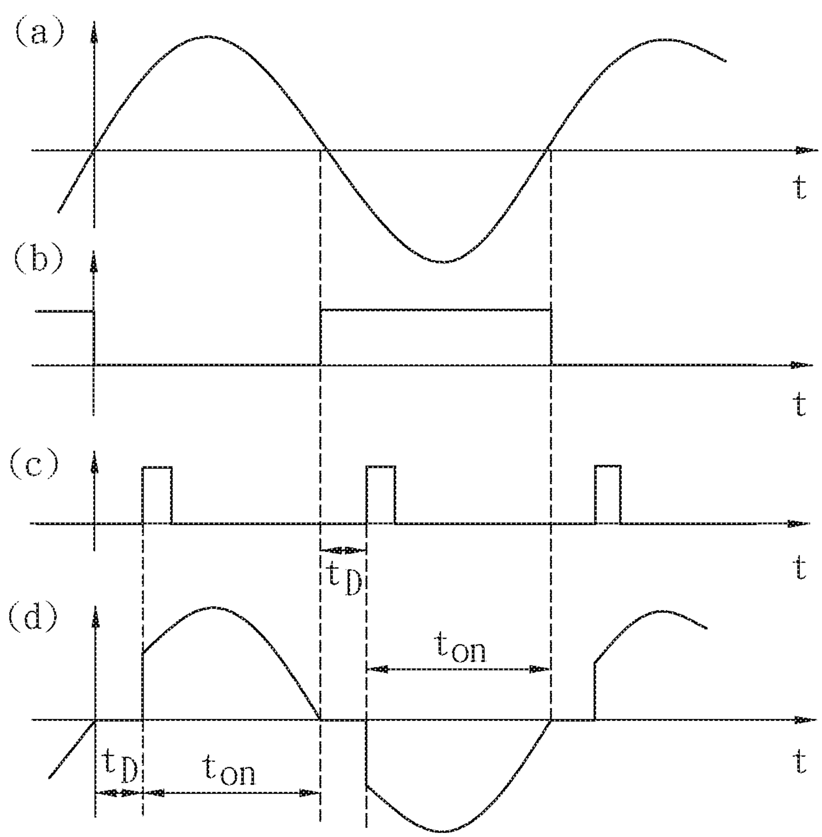


FIG. 4B

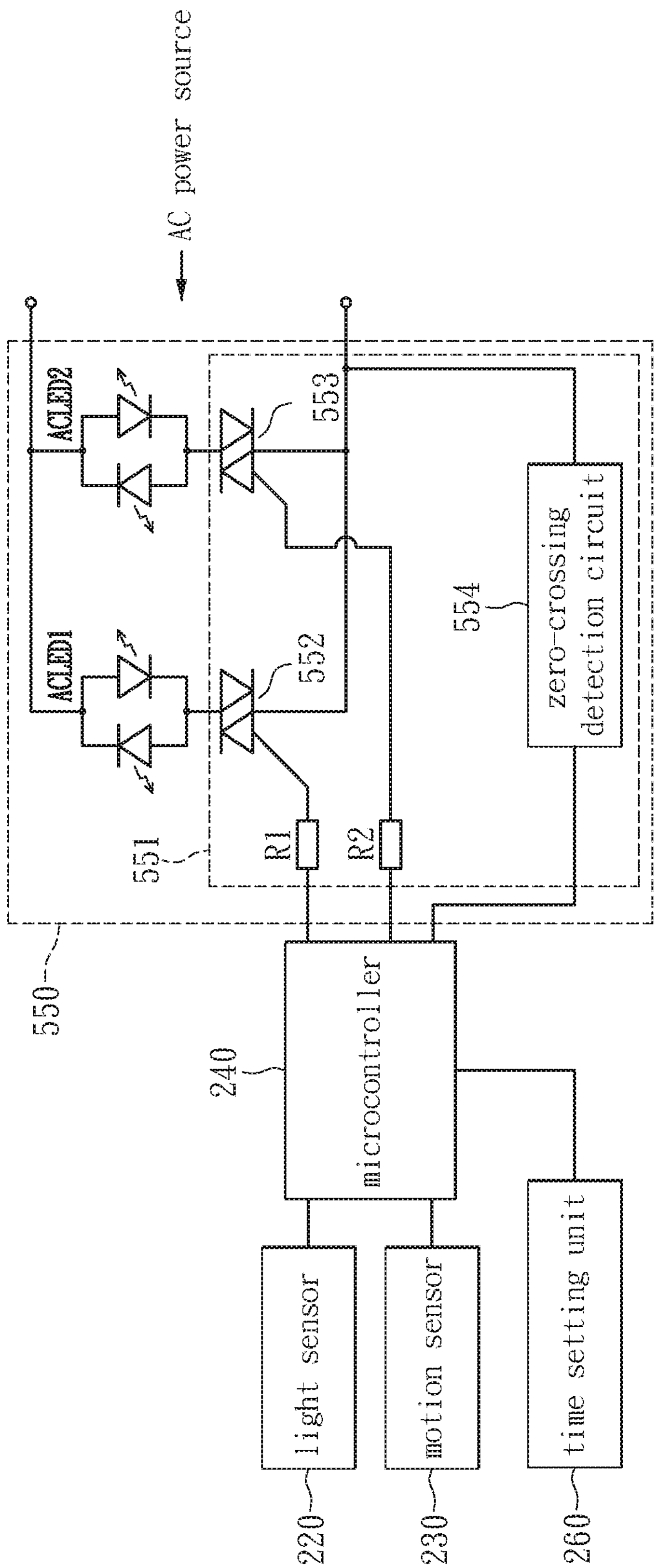

AC power source
ACLED2
553
ACLED1
552
551
R1
R2
554
zero-crossing detection circuit
550
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

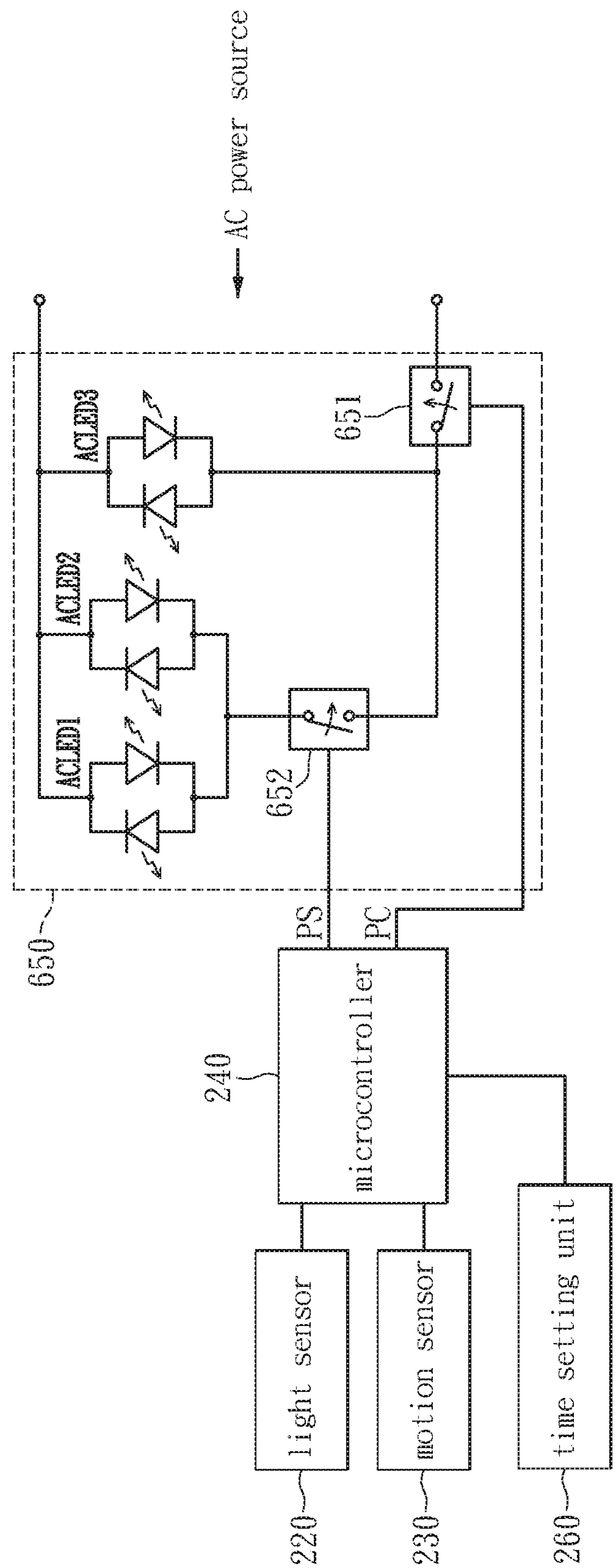

AC power source
ACLED3
ACLED2
ACLED1
651
652
650
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

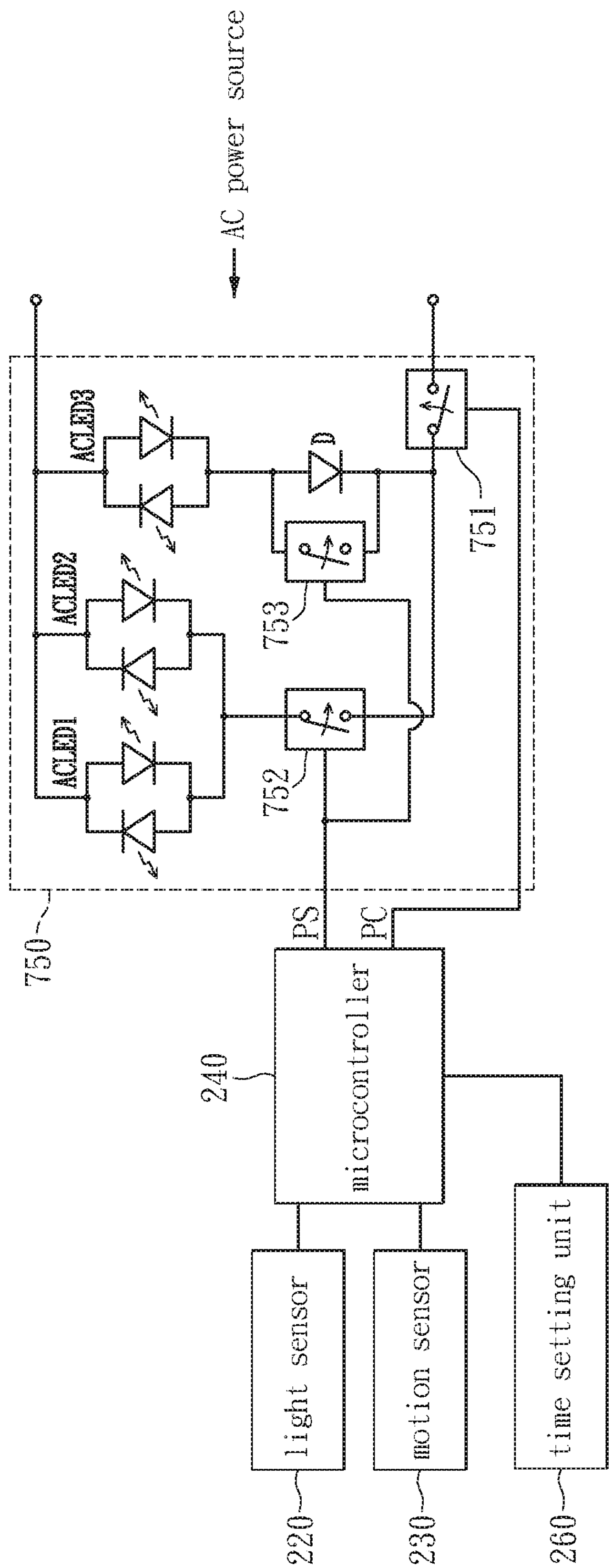

AC power source
ACLED1
ACLED2
ACLED3
D
751
752
753
750
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

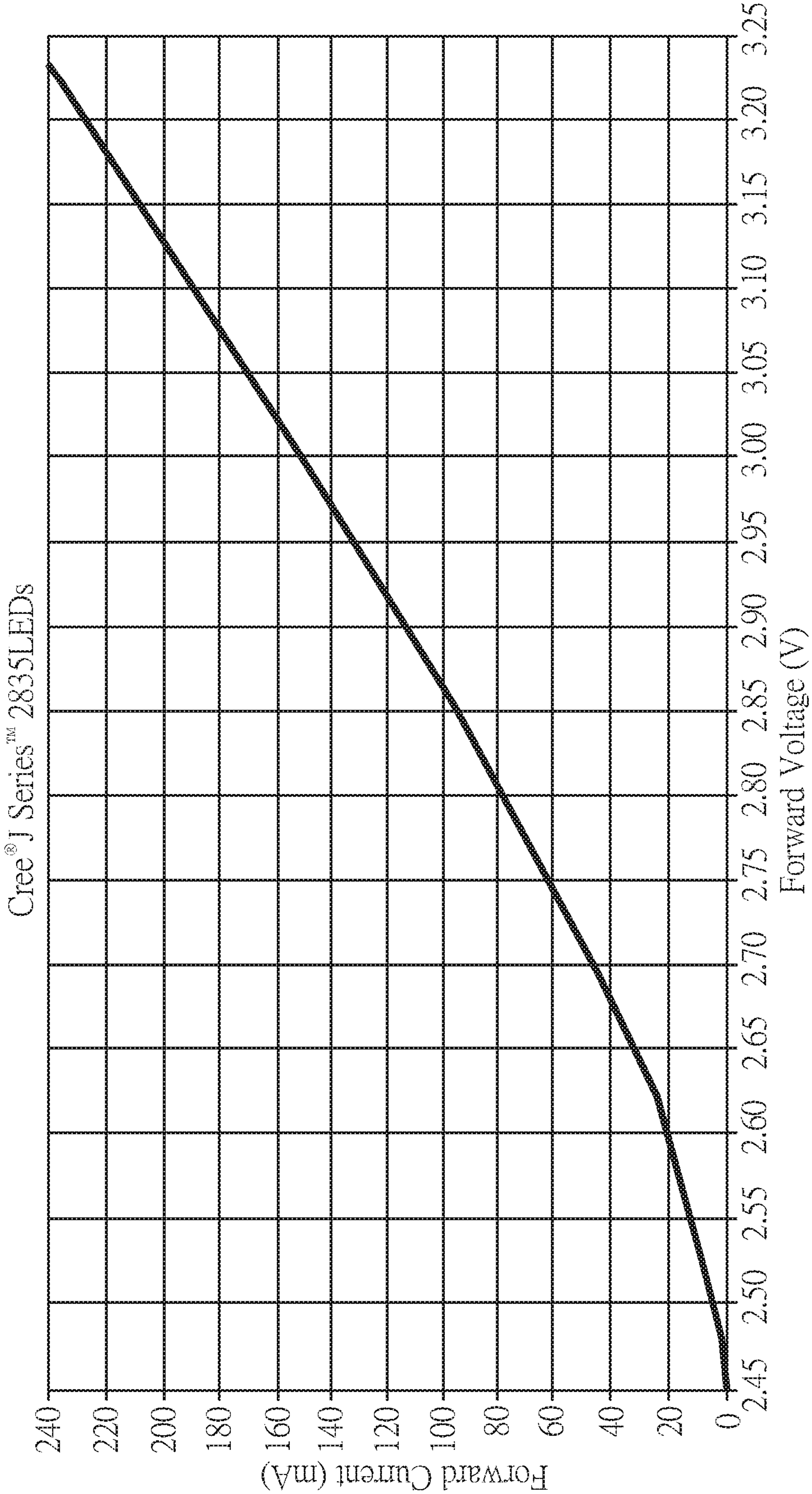

Cree® J Series™ 2835LEDs
Forward Current (mA)
0
20
40
60
80
100
120
140
160
180
200
220
240
Forward Voltage (V)
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25

FIG. 8A

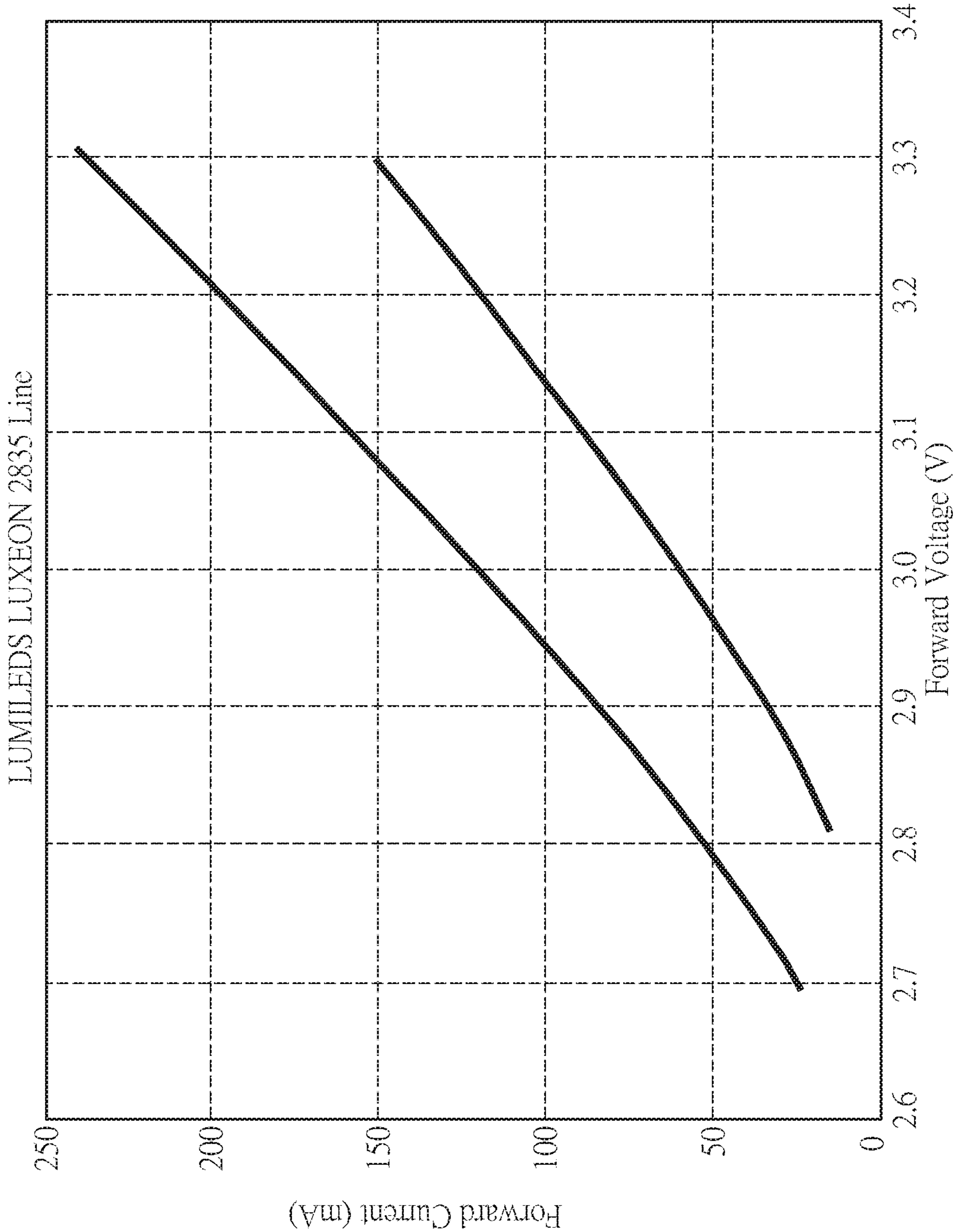

LUMILEDS LUXEON 2835 Line
Forward Current (mA)
0
50
100
150
200
250
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4

FIG. 8B

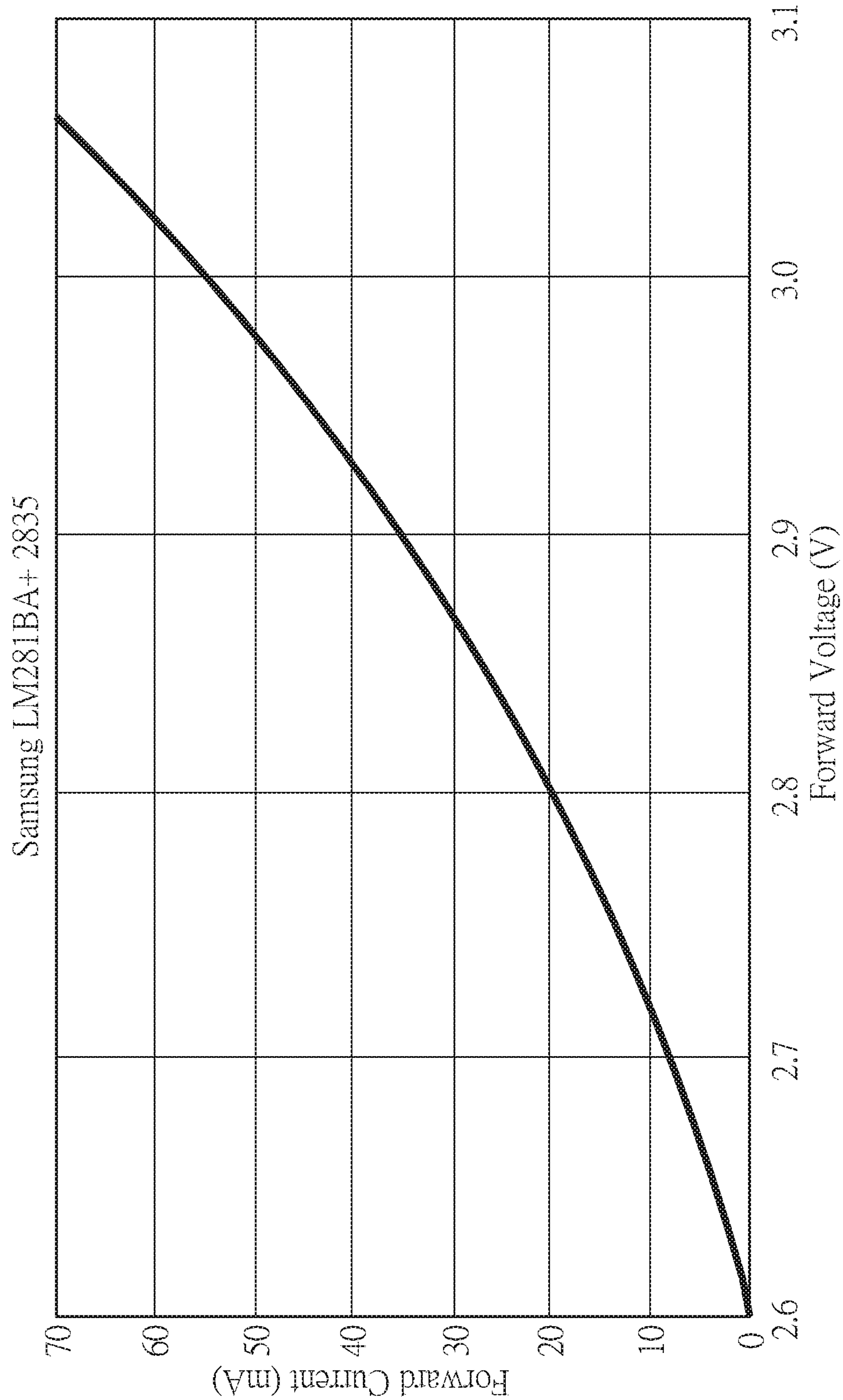

Samsung LM281BA+ 2835
70
60
50
40
30
20
10
0
Forward Current (mA)
2.6
2.7
2.8
2.9
3.0
3.1
Forward Voltage (V)

FIG. 8C

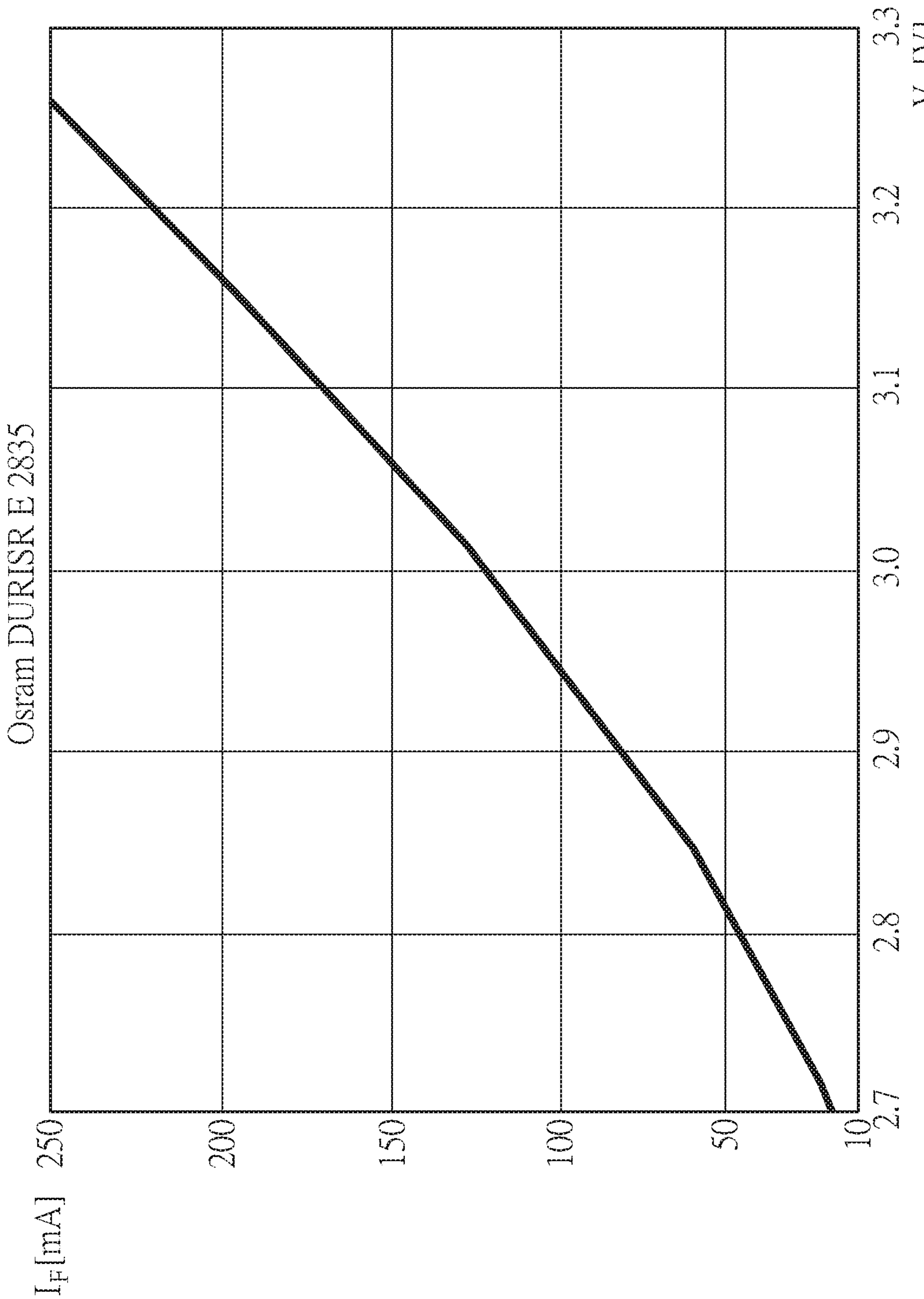

Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
V_F [V]
2.7
2.8
2.9
3.0
3.1
3.2
3.3

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation of application Ser. No. 16/244,671, filed Jan. 10, 2019. Ser. No. 16/244,671 is a continuation of application Ser. No. 15/896,403, filed Feb. 14, 2018, which issued as U.S. Pat. No. 10,225,902 on Mar. 5, 2019. U.S. Pat. No. 10,225,902 is a continuation of application Ser. No. 15/785,658, filed Oct. 17, 2017, which issued as U.S. Pat. No. 10,326,301 on Jun. 18, 2019. U.S. Pat. No. 10,326,301 is a continuation of application Ser. No. 15/375,777, filed Dec. 12, 2016, which issued as U.S. Pat. No. 9,826,590 on Nov. 21, 2017. U.S. Pat. No. 9,826,590 is a continuation of application Ser. No. 14/836,000, filed Aug. 26, 2015, which issued as U.S. Pat. No. 9,622,325 on Apr. 11, 2017. U.S. Pat. No. 9,622,325 is a divisional of application Ser. No. 14/478,150, filed Sep. 5, 2014, which issued as U.S. Pat. No. 9,445,474 on Sep. 13, 2016. U.S. Pat. No. 9,445,474 is a continuation of application Ser. No. 13/222,090, filed Aug. 31, 2011, which issued as U.S. Pat. No. 8,866,392 on Oct. 21, 2014.

BACKGROUND OF THE INVENTION

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photoresistors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY OF THE INVENTION

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a phase controller and one or a plurality of parallel-connected alternating current (AC)LEDs. The phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power

supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto-turnoff at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediate switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification.

The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an AC LED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the AC LED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **1**C is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a AC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises bidirectional semiconductor switching devices for controlling an average electric power to be delivered to the AC LED.

FIG. **1**D is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises unidirectional semiconductor switching devices for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C and **8**D schematically and respectively show I-V relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. A two-level LED security light (herein as the lighting apparatus) **100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs and switching components. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that the ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flow through the light-emitting unit **150**, to generate the high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein the DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a pulse width modulation (PWM) signal to the gate of transistor Q**1** to control the average electric current. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{off} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow the user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto. The time setting unit is a type of external control units designed to detect various external control signals and to convert the various external control signals into various message signals interpretable by the controller for setting various operating parameters of a security light including at least a time length setting for various illumination modes, a light intensity setting for various illumination modes and switching between illumination modes. The external control units may be configured with a push button, a touch sensor, a voltage

divider, a power interruption detection circuitry or a wireless remote control receiver for generating message signals interpretable by the controller.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. **3**A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A and FIG. **2**A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** detects that the ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may include a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include a phase controller and one or more parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** includes a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is

higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger thetriac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<½f-t_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(½\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t(rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (½f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D<6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low

voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**, and a phase controller **551**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R1 and R2. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLEDs and more than one bi-directional switching devices. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the

light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1**~**3** having identical luminous power as well as switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1**~**3** are coupled to the AC power source and the light-emitting unit **650** may generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED3 is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ALCED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1**~**3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751**~**753** to render ACLED**1**~**3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs. In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

When the light source of the light emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of a voltage operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the voltage operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the threshold voltage and the maximum working voltage.

In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as the threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is the threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the threshold voltage into a

corresponding time phase of AC power for lighting control, it is necessary to use the term V_{th} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V is a voltage across the LED chip, V_{th} is the threshold voltage to enable the LED chip to start emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working voltage V of each single LED chip is required to operate in a domain between a threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage V_N of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a threshold voltage of N times $V_{th}(N\times V_{th})$ and a maximum working voltage of N times $V_{max}(N\times V_{max})$ or $N\times V_{th}<V_N<N\times V_{max}$, wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V_N across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N\times V_{th}<V_N<N\times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises **4** drawings schematically and respectively showing a I-V relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage, i.e., the threshold voltage or the cut-in voltage, and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers. The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount of monetary relief was claimed with the Court in the complaint.

The present disclosure of a two-level LED security light provides a unique life-style lighting solution. The motivation of creating such life-style lighting solution has less to do with the energy saving aspect of the low level illumination mode because an LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the life-style lighting solution of the present disclosure is featured with two innovations which meaningfully improve the exquisite tastes of living in the evening, the first innovation is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination with a low color temperature which is necessary for creating a soft and aesthetic night scene for the outdoor living area (such soft and aesthetic night view is not achievable by the high level illumination however), the second innovation is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without

getting lost or encountering an accident, wherein when a motion intrusion is detected by the motion sensor the security light is instantly changed to perform a high level illumination mode with a high color temperature light which offers people a high visibility of the surrounding environment when needed. For the visibility of a surrounding environment the high color temperature light is the winner while for the creation of a soft and aesthetic night view there is no substitute for the low color temperature light. It is the innovation of the present invention to configure a life-style security light with a low color temperature LED load and a high color temperature LED load respectively activated by a photo sensor and a motion sensor to resemble the natural phenomenon of a sun light. These two innovative functions ideally implemented by the LED loads coupled with the motion sensor to increase illumination with a high visibility when people enters into the short detection area make the present invention a perfect life-style lighting solution for enjoying an exquisite taste of evening life.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. An LED security light comprising:

a light-emitting unit comprising a plurality of LEDs divided into two LED loads connected in parallel, including a first LED load with N number LEDs emitting light with a low light color temperature and a second LED load with M number LEDs emitting light with a high light color temperature, wherein M and N are positive integers;

a light diffuser covering the first LED load and the second LED load to create a diffused light with a diffused light color temperature;

a loading and power control unit;

a light sensing control unit;

a power supply unit; and

an external control unit including at least a first external control device outputting at least one first external control signal to tune and to select the diffused light color temperature;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the switching circuitry is electrically coupled between at least one DC power source of the power supply unit and the light-emitting unit for controlling and delivering at least one DC power to the light-emitting unit, wherein the switching circuitry comprises a first semiconductor switching device electrically connected to the first LED load and a second semiconductor switching device electrically connected to the second LED load;

wherein the controller is electrically coupled with the first semiconductor switching device, the second semiconductor switching device, the light sensing control unit and at least the first external control device;

wherein when the light-emitting unit is in a turned on state, the controller further outputs a first control signal to control a first conduction rate of the first semiconductor switching device and a second control signal to control a second conduction rate of the second semiconductor switching device to respectively deliver a first electric power to the first LED load and a second electric power to the second LED load to generate the

diffused light with the diffused light color temperature thru the diffuser according to the at least one first external control signal;

wherein for tuning the diffused light color temperature to a lower diffused light color temperature, the controller upon receiving the at least one first external control signal operates to increase the first conduction rate of the first semiconductor switching device to increase the first electric power delivered to the first LED load and simultaneously operates to decrease the second conduction rate of the second semiconductor switching device to decrease the second electric power delivered to the second LED load with the same pace such that a total diffused light intensity generated by the light-emitting unit remains essentially unchanged while the diffused light color temperature is accordingly adjusted to the lower diffused light color temperature;

wherein for tuning the diffused light color temperature to a higher diffused light color temperature, the controller upon receiving the at least one first external control signal operates to decrease the first conduction rate of the first semiconductor switching device to decrease the first electric power delivered to the first LED load and simultaneously operates to increase the second conduction rate of the second semiconductor switching device to increase the second electric power delivered to the second LED load with the same pace such that the total light intensity generated by the light-emitting unit remains essentially unchanged while the diffused light color temperature is accordingly adjusted to the higher diffused light color temperature;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to turn on the light-emitting unit to perform the diffused light with a selected diffused light color temperature;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to turn off all the LEDs in the light-emitting unit;

wherein the N number LEDs of the first LED load and the M number LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with a power level setting of the at least one DC power an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

2. The LED security light according to claim **1**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first LED load and the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

3. The LED security light according to claim 2, wherein when the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts<V_{th}<V<V_{max}<3.5 volts, the first LED load and the second LED load are required to operate with respective working voltages V_N and V_M confined in domains expressed by N_S×2.5 volts<V_N<N_S×3.5 volts and M_S×2.5 volts<V_M<M_S×3.5 volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first LED load and the second LED load, wherein N_S≤N and M_S≤M.

4. The LED security light according to claim 1, wherein the controller is designed with a diffused light color temperature switching scheme comprising a plurality of different diffused light color temperature performances to be activated by the first external control device, wherein different paired combinations of the first conduction rate and the second conduction rate respectively for controlling the first electric power delivered to the first LED load and the second electric power delivered to the second LED load for creating different diffused light color temperature performances are preprogrammed and executed by the controller for operating a pick and play process according to the at least one first external control signal generated by the first external control device for selecting a corresponding diffused light color temperature performance in the diffused light color temperature switching scheme.

5. The LED security light according to claim 4, wherein the at least one first external control signal is a short power interruption signal generated by operating a main power switch, a push button, a touch sensor or a wireless remote control device, wherein a power interruption detection circuit is electrically coupled with the controller, wherein when the short power interruption signal is detected by the power interruption detection circuit, the controller operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to a prearranged sequence.

6. The LED security light according to claim 5, wherein when the main power switch is used for generating the short power interruption signal, the main power switch is turned off and turned back on within a predetermined time interval.

7. The LED security light according to claim 5, wherein when the push button or the touch sensor is used, a signal detection circuitry is connected to the push button or the touch sensor, wherein when the push button or the touch sensor is operated, a voltage signal is transmitted to the signal detection circuitry to actuate a momentary power interruption and consequently the short power interruption signal is generated and detected by the power interruption detection circuit, the controller accordingly operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to a prearranged sequence.

8. The LED security light according to claim 4, wherein the first external control device is a voltage divider operated by a user to output a plurality of voltage signals interpretable by the controller for executing the pick and play process for respectively selecting and performing the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme; wherein the voltage divider is configured to output the plurality of voltage signals respectively represented by a voltage value, wherein the controller operates to activate the diffused light color temperature switching scheme to generate a corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to the voltage value outputted by the voltage divider.

9. The LED security light according to claim 8, wherein the voltage divider is operated with a configuration of a slide switch, a rotary switch, or a pull chain switch, designed with a plurality of switching positions operable by a user for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

10. The LED security light according to claim 4, wherein the first external control device is a wireless remote control device comprising at least one wireless external signal receiver electrically coupled with the controller to receive at least one wireless external control signal and convert the at least one wireless external control signal into the at least one first external control signal interpretable by the controller for activating the pick and play process to select and perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme.

11. The LED security light according to claim 4, wherein the first external control device is an active infrared ray sensor for detecting an infrared light reflected from an object and converting the infrared light reflected from the object into the at least one first external control signal interpretable by the controller for executing the pick and play process for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

12. The LED security light according to claim 4, wherein the diffused light color temperature switching scheme comprises at least a high diffused light color temperature performance and a low diffused light color temperature performance, wherein for performing the high diffused light color temperature performance the second semiconductor switching device is fully conducted and the first semiconductor switching device is completely cut off, wherein for performing the low diffused light color temperature performance the first semiconductor switching device is fully conducted and the second semiconductor switching device is completely cut off.

13. The LED security light according to claim 4, wherein the light color temperature switching scheme comprises at least a high diffused light color temperature performance, a low diffused light color temperature performance and a medium diffused light color temperature performance, wherein for performing the high diffused light color temperature performance the second semiconductor switching device is fully conducted and the first semiconductor switching device is completely cut off, wherein for performing the low diffused light color temperature performance the first semiconductor switching device is fully conducted while the second semiconductor switching device is completely cut off, wherein for performing the medium diffused light color temperature performance the first semiconductor switching device and the second semiconductor switching device are both partially and complementarily conducted such that the total light intensity generated by the light-emitting unit remains essentially unchanged.

14. The LED security light according to claim 13, wherein the controller is further designed with a free running process to operate a free running performance of the diffused light color temperature switching scheme, wherein a second external control device is designed to output a second external control signal to activate the free running process, wherein the controller manages to operate the free running process to gradually rotate a running pick and play of the diffused light color temperature switching scheme, wherein

the free running process operates to perform the low diffused light color temperature performance first for a predetermined short time interval, and then is switched to perform the medium diffused light color temperature performance for the predetermined short time interval, and then is switched to perform the high diffused light color temperature performance for the predetermined short time interval to complete a free running cycle, the free running cycle continues till the second external control signal is ceased or till the second external control device outputs another second external control signal to end the free running process.

15. The LED security light according to claim **4**, wherein the at least one external control device is a push button or a touch sensor, wherein when the push button or the touch sensor is operated, the controller accordingly operates to activate the pick and play process to alternately perform one of the diffused light color temperatures in the diffused light color temperature switching scheme according to a prearranged sequence.

16. The LED security light according to claim **4**, wherein the at least one external control device is a selection switch electrically connectable to a plurality of switching positions with each switching position being electrically and respectively coupled with a control pin of the controller, wherein when the selection switch is connected to one of the plurality of switching positions a constant voltage signal is delivered to a corresponding control pin of the controller to activate the diffused light color temperature switching scheme for selecting the corresponding diffused light color temperature.

17. The LED security light according to claim **1**, wherein M is equal to N.

18. The LED security light according to claim **1**, wherein M is smaller than N.

19. The LED security light according to claim **1**, wherein the low color temperature is designed in a range between 2000 K and 3000 K, the high color temperature is designed in the range between 5000 K and 6500 K.

20. An LED security light comprising:

a light-emitting unit comprising a plurality of LEDs divided into two LED loads connected in parallel, including a first LED load with N number LEDs emitting light with a low light color temperature and a second LED load with M number LEDs emitting light with a high light color temperature, wherein M and N are positive integers;

a light diffuser covering the first LED load and the second LED load to create a diffused light with a diffused light color temperature;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

an external control unit including at least a first external control device outputting at least one first external control signal to tune and to select the diffused light color temperature;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the switching circuitry is electrically coupled between at least one DC power source of the power supply unit and the light-emitting unit for controlling and delivering at least one DC power to the light-emitting unit, wherein the switching circuitry comprises a first semiconductor switching device electrically connected to the first LED load and a second semiconductor switching device electrically connected to the second LED load;

wherein the controller is electrically coupled with the first semiconductor switching device, the second semiconductor switching device, the light sensing control unit, the motion sensing unit and at least the first external control device;

wherein when the light-emitting unit is in a turned on state, the controller further outputs a first control signal to control a first conduction rate of the first semiconductor switching device and a second control signal to control a second conduction rate of the second semiconductor switching device to respectively deliver a first electric power to the first LED load and a second electric power to the second LED load to generate the diffused light with the diffused light color temperature thru the diffuser according to the at least one first external control signal;

wherein for tuning the diffused light color temperature to a lower diffused light color temperature, the controller upon receiving the at least one first external control signal operates to increase the first conduction rate of the first semiconductor switching device to increase the first electric power delivered to the first LED load and simultaneously operates to decrease the second conduction rate of the second semiconductor switching device to decrease the second electric power delivered to the second LED load with the same pace such that a total diffused light intensity generated by the light-emitting unit remains essentially unchanged while the diffused light color temperature is accordingly adjusted to the lower diffused light color temperature;

wherein for tuning the diffused light color temperature to a higher diffused light color temperature, the controller upon receiving the at least one first external control signal operates to decrease the first conduction rate of the first semiconductor switching device to decrease the first electric power delivered to the first LED load and simultaneously operates to increase the second conduction rate of the second semiconductor switching device to increase the second electric power delivered to the second LED load with the same pace such that the total light intensity generated by the light-emitting unit remains essentially unchanged while the diffused light color temperature is accordingly adjusted to the higher diffused light color temperature;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to activate the motion sensing unit;

wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit operates to deliver an electric power to the light-emitting unit to generate a high level illumination with a selected diffused light color temperature according to a sensing signal received from the motion sensing unit for a predetermined time duration before resuming to a turned off state of the light-emitting unit;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to deactivate the motion sensing unit and turn off all LEDs of the light-emitting unit;

wherein the N number LEDs of the first LED load and the M number LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with a power level setting of the at least one DC power an electric current passing through each LED of the

first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

21. The LED security light according to claim **20**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first LED load and the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum operating voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

22. The LED security light according to claim **21**, wherein when the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts, the first LED load and the second LED load are required to operate with respective working voltages V_N and V_M confined in domains expressed by $N_S\times2.5$ volts$<V_N<N_S\times3.5$ volts and $M_S\times2.5$ volts$<V_M<M_S\times3.5$ volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first LED load and the second LED load, wherein $N_S\leq N$ and $M_S\leq M$.

23. The LED security light according to claim **20**, wherein the controller is designed with a diffused light color temperature switching scheme comprising a plurality of different diffused light color temperature performances to be activated by the first external control device, wherein different paired combinations of the first conduction rate and the second conduction rate respectively for controlling the first electric power delivered to the first LED load and the second electric power delivered to the second LED load for creating different diffused light color temperatures are preprogrammed and executed by the controller for operating a pick and play process according to the at least one first external control signal generated by the first external control device for selecting a corresponding diffused light color temperature performance in the diffused light color temperature switching scheme.

24. The LED security light according to claim **23**, wherein the at least one first external control signal is a short power interruption signal generated by operating a main power switch, a push button, a touch sensor or a wireless remote control device, wherein a power interruption detection circuit is electrically coupled with the controller, wherein when the short power interruption signal is detected by the power interruption detection circuit, the controller operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to a prearranged sequence.

25. The LED security light according to claim **24**, wherein when the main power switch is used for generating the short power interruption signal, the main power switch is turned off and turned back on within a predetermined time interval.

26. The LED security light according to claim **24**, wherein when the push button or the touch sensor is used, a signal detection circuitry is connected to the push button or the touch sensor, wherein when the push button or the touch sensor is operated, a voltage signal is transmitted to the signal detection circuitry to actuate a momentary power interruption and consequently the short power interruption signal is generated and detected by the power interruption detection circuit, the controller accordingly operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to a prearranged sequence.

27. The LED security light according to claim **23**, wherein the first external control device is a voltage divider operated by a user to output a plurality of voltage signals interpretable by the controller for executing the pick and play process for respectively selecting and performing the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme; wherein the voltage divider is configured to output the plurality of voltage signals respectively represented by a voltage value, wherein the controller operates to activate the diffused light color temperature switching scheme to generate a corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to the voltage value outputted by the voltage divider.

28. The LED security light according to claim **12**, wherein the voltage divider is operated with a configuration of a slide switch, a rotary switch, or a pull chain switch, designed with a plurality of switching positions operable by a user for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

29. The LED security light according to claim **23**, wherein the first external control device is a wireless remote control device comprising at least one wireless external signal receiver electrically coupled with the controller to receive at least one wireless external control signal and convert the at least one wireless external control signal into the at least one first external control signal interpretable by the controller for activating the pick and play process to select and perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme.

30. The LED security light according to claim **23**, wherein the first external control device is an active infrared ray sensor for detecting an infrared light reflected from an object and converting the infrared light reflected from the object into the at least one first external control signal interpretable by the controller for executing the pick and play process for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

31. The LED security light according to claim **23**, wherein the diffused light color temperature switching scheme comprises at least a high diffused light color temperature performance and a low diffused light color temperature performance, wherein for performing the high diffused light color temperature performance the second semiconductor switching device is fully conducted and the first semiconductor switching device is completely cut off, wherein for performing the low diffused light color temperature performance the first semiconductor switching device is fully conducted and the second semiconductor switching device is completely cut off.

32. The LED security light according to claim **23**, wherein the diffused light color temperature switching scheme comprises at least a high diffused light color temperature performance, a low diffused light color temperature performance and a medium diffused light color temperature performance, wherein for performing the high diffused light color temperature performance the second semiconductor

switching device is fully conducted and the first semiconductor switching device is completely cut off, wherein for performing the low diffused light color temperature performance the first semiconductor switching device is fully conducted while the second semiconductor switching device is completely cut off, wherein for performing the medium diffused light color temperature performance the first semiconductor switching device and the second semiconductor switching device are both partially and complementarily conducted such that the total light intensity generated by the light-emitting unit remains essentially unchanged.

33. The LED security light according to claim **32**, wherein the controller is further designed with a free running process to operate a free running performance of the diffused light color temperature switching scheme, wherein a second external control device is designed to output a second external control signal to activate the free running process, wherein the controller manages to operate the free running process to gradually rotate a running pick and play of the diffused light color temperature switching scheme, wherein the free running process operates to perform the low diffused light color temperature performance first for a predetermined short time interval, and then is switched to perform the medium diffused light color temperature performance for the predetermined short time interval, and then is switched to perform the high diffused light color temperature performance for the predetermined short time interval to complete a free running cycle, the free running cycle continues till the second external control signal is ceased or till the second external control device outputs another second external control signal to end the free running process.

34. The LED security light according to claim **23**, wherein the at least one external control device is a push button or a touch sensor, wherein when the push button or the touch sensor is operated, the controller accordingly operates to activate the pick and play process to alternately perform one of the diffused light color temperatures in the diffused light color temperature switching scheme according to a prearranged sequence.

35. The LED security light according to claim **23**, wherein the at least one external control device is a selection switch electrically connectable to a plurality of switching positions with each switching position being electrically and respectively coupled with a control pin of the controller, wherein when the selection switch is connected to one of the plurality of switching positions a constant voltage signal is delivered to a corresponding control pin of the controller to activate the diffused light color temperature switching scheme for selecting the corresponding diffused light color temperature.

36. The LED security light according to claim **20**, wherein M is equal to N.

37. The LED security light according to claim **20**, wherein M is smaller than N.

38. The LED security light according to claim **20**, wherein the low color temperature is designed in a range between 2000 K and 3000 K, the high color temperature is designed in the range between 5000 K and 6500 K.

39. A method of configuring an LED lighting device with a tunable diffused light color temperature, comprising:

using a light-emitting unit comprising a plurality of LEDs being divided into at least two LED loads including at least a first LED load with N number LEDs emitting light with a low color temperature and at least a second LED load with M number LEDs emitting light with a high color temperature; the first LED load and the second LED load being electrically connected in parallel;

using a light diffuser covering the first LED load and the second LED load to create a diffused light with a diffused light color temperature;

using an LED driver circuitry electrically coupled between a power source and the light-emitting unit to output at least one DC power to the light-emitting unit;

using a first semiconductor switching device electrically connected between the LED driver circuitry and the first LED load to control a power level of a first electric power delivered to the first LED load;

using a second semiconductor switching device electrically connected between the LED driver circuitry and the second LED load to control a power level of a second electric power delivered to the second LED load;

using a controller, electrically coupled with the first semiconductor switching device and the second semiconductor switching device to respectively control a first conduction rate of the first semiconductor switching device and a second conduction rate of the second semiconductor switching device;

using at least a first external control device electrically coupled with the controller to output at least one first external control signal to tune and to select a corresponding diffused light color temperature performance;

wherein when the light-emitting unit is in a turned on state, the controller outputs the first control signal to control the first conduction rate of the first semiconductor switching device and the second control signal to control the second conduction rate of the second semiconductor switching device to respectively deliver the first electric power to the first LED load and the second electric power to the second LED load to generate the diffused light with the diffused light color temperature thru the diffuser according to the at least one first external control signal;

wherein for tuning the diffused light color temperature to a lower diffused light color temperature, the controller upon receiving the at least one first external control signal operates to increase the first conduction rate of the first semiconductor switching device to increase the first electric power delivered to the first LED load and simultaneously operates to decrease the second conduction rate of the second semiconductor switching device to decrease the second electric power delivered to the second LED load with the same pace such that a total diffused light intensity generated by the light-emitting unit remains essentially unchanged while the diffused light color temperature is accordingly adjusted to the lower diffused light color temperature;

wherein for tuning the diffused light color temperature to a higher diffused light color temperature, the controller upon receiving the at least one first external control signal operates to decrease the first conduction rate of the first semiconductor switching device to decrease the first electric power delivered to the first LED load and simultaneously operates to increase the second conduction rate of the second semiconductor switching device to increase the second electric power delivered to the second LED load with the same pace such that the total light intensity generated by the light-emitting unit remains essentially unchanged while the diffused light color temperature is accordingly adjusted to the higher diffused light color temperature;

wherein the first LED load and the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with a power level setting of the at least one DC power an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate

level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

40. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **39**, wherein the controller is designed with a diffused light color temperature switching scheme comprising a plurality of different diffused light color temperature performances to be respectively activated by the at least one first external control signal generated by the first external control device, wherein different paired combinations of the first conduction rate and the second conduction rate respectively for controlling the first electric power delivered to the first LED load and the second electric power delivered to the second LED load for creating different diffused light color temperatures are preprogrammed and executed by the controller for operating a pick and play process according to the at least one first external control signal generated by the first external control device for selecting a corresponding diffused light color temperature performance in the diffused light color temperature switching scheme.

41. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **40**, wherein the at least one first external control signal is a short power interruption signal generated by operating a main power switch, a push button, a touch sensor or a wireless remote control device, wherein a power interruption detection circuit is electrically coupled with the controller, wherein when the short power interruption signal is detected by the power interruption detection circuit, the controller operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to a prearranged sequence.

42. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **41**, wherein when the main power switch is used for generating the short power interruption signal, the main power switch is turned off and turned back on within a predetermined time interval.

43. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **41**, wherein when the push button or the touch sensor is used, a signal detection circuitry is connected to the push button or the touch sensor, wherein when the push button or the touch sensor is operated, a voltage signal is transmitted to the signal detection circuitry to actuate a momentary power interruption and consequently the short power interruption signal is generated and detected by the power interruption detection circuit, the controller accordingly operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to the prearranged sequence.

44. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **40**, wherein the first external control device is a voltage divider operated by a user to output a plurality of voltage signals interpretable by the controller for executing the pick and play process for respectively selecting and performing the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme; wherein the voltage divider is configured to output the plurality of voltage signals respectively represented by a voltage value, wherein the controller operates to activate the diffused light color temperature switching scheme to generate a corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to the voltage value outputted by the voltage divider.

45. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **44**, wherein the voltage divider is operated with a configuration of a slide switch, a rotary switch, or a pull chain switch, designed with a plurality of switching positions operable by a user for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

46. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **40**, wherein the first external control device is a wireless remote control device comprising at least one wireless external signal receiver electrically coupled with the controller to receive at least one wireless external control signal and convert the at least one wireless external control signal into the at least one first external control signal interpretable by the controller for activating the pick and play process to select and perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme.

47. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **40**, wherein the first external control device is an active infrared ray sensor for detecting an infrared light reflected from an object and converting the infrared light reflected from the object into the at least one first external control signal interpretable by the controller for executing the pick and play process for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

48. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **40**, wherein the diffused light color temperature switching scheme comprises at least a high diffused light color temperature performance and a low diffused light color temperature performance, wherein for performing the high diffused light color temperature performance the second semiconductor switching device is fully conducted and the first semiconductor switching device is completely cut off, wherein for performing the low diffused light color temperature performance the first semiconductor switching device is fully conducted and the second semiconductor switching device is completely cut off.

49. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **40**, wherein the diffused light color temperature switching scheme comprises at least a high diffused light color temperature performance, a low diffused light color temperature performance and a medium diffused light color temperature performance, wherein for performing the high diffused light color temperature performance the second semiconductor switching device is fully conducted and the first semiconductor switching device is completely cut off, wherein for performing the low diffused light color temperature performance the first semiconductor switching device is fully conducted while the second semiconductor switching device is completely cut off, wherein for performing the medium diffused light color temperature performance the first semiconductor switching device and the second semiconductor switching device are both partially

and complementarily conducted such that the total light intensity generated by the light-emitting unit remains essentially unchanged.

50. The method of configuring an LED lighting device with a tunable diffused light color temperature according claim **49**, wherein the controller is further designed with a free running process to operate a free running performance of the diffused light color temperature switching scheme, wherein a second external control device is designed to output a second external control signal to activate the free running process, wherein the controller manages to operate the free running process to gradually rotate a running pick and play of the diffused light color temperature switching scheme, wherein the free running process operates to perform the low diffused light color temperature performance first for a predetermined short time interval, and then is switched to perform the medium diffused light color temperature performance for the predetermined short time interval, and then is switched to perform the high diffused light color temperature performance for the predetermined short time interval to complete a free running cycle, the free running cycle continues till the second external control signal is ceased or till the second external control device outputs another second external control signal to end the free running process.

51. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **40**, wherein the at least one external control device is a push button or a touch sensor, wherein when the push button or the touch sensor is operated the controller accordingly operates to activate the pick and play process to alternately perform one of the diffused light color temperatures in the diffused light color temperature switching scheme according to a prearranged sequence.

52. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **40**, wherein the at least one external control device is a selection switch electrically connectable to a plurality of switching positions with each switching position being electrically and respectively coupled with a control pin of the controller, wherein when the selection switch is connected to one of the plurality of switching positions a constant voltage signal is delivered to a corresponding control pin of the controller to activate the diffused light color temperature switching scheme for selecting the corresponding diffused light color temperature.

53. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **39**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first LED load and the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

54. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **53**, wherein when the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts, the first LED load and the second LED load are required to operate with respective

working voltages V_N and V_M confined in domains expressed by $N_S \times 2.5$ volts$<V_N<N_S \times 3.5$ volts and $M_S \times 2.5$ volts$<V_M<M_S \times 3.5$ volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first LED load and the second LED load, wherein $N_S \leq N$ and $M_S \leq M$.

55. The method of configuring an LED lighting device with a tunable diffused light color temperature according to claim **39**, wherein the low color temperature is designed in a range between 2000 K and 3000 K, the high color temperature is designed in the range between 5000 K and 6500 K.

56. An LED lighting device configured with a tunable diffused light color temperature, comprising:

a light-emitting unit comprising a plurality of LEDs divided into at least two LED loads including at least a first LED load with N number LEDs emitting light with a low color temperature and at least a second LED load with M number LEDs emitting light with a high color temperature; the first LED load and the second LED load being electrically connected in parallel;

a light diffuser covering the first LED load and the second LED load to create a diffused light with a diffused light color temperature;

an LED driver circuitry electrically connected to at least one power source to output at least one DC power to the light-emitting unit;

a first semiconductor switching device electrically connected between the LED driver circuitry and the first LED load;

a second semiconductor switching device electrically connected between the LED driver circuitry and the second LED load;

at least a first external control device to output at least one first external control signal to tune and to select a corresponding diffused light color temperature performance; and

a controller, electrically coupled with the first semiconductor switching device, the second semiconductor switching device and at least the first external control device;

wherein when the light-emitting unit is in a turned on state, the controller outputs a first control signal to control a first conduction rate of the first semiconductor switching device and a second control signal to control the second conduction rate of the second semiconductor switching device to respectively deliver a first electric power to the first LED load and a second electric power to the second LED load to generate the diffused light with the diffused light color temperature thru the diffuser according to the at least one first external control signal;

wherein for tuning the diffused light color temperature to a lower diffused light color temperature, the controller upon receiving the at least one first external control signal operates to increase the first conduction rate of the first semiconductor switching device to increase the first electric power delivered to the first LED load and simultaneously operates to decrease the second conduction rate of the second semiconductor switching device to decrease the second electric power delivered to the second LED load with the same pace such that a total diffused light intensity generated by the light-emitting unit remains essentially unchanged while the diffused light color temperature is accordingly adjusted to the lower diffused light color temperature;

wherein for tuning the diffused light color temperature to a higher diffused light color temperature, the controller upon receiving the at least one first external control signal operates to decrease the first conduction rate of the first semiconductor switching device to decrease the first electric power delivered to the first LED load and simultaneously operates to increase the second conduction rate of the second semiconductor switching device to increase the second electric power delivered to the second LED load with the same pace such that the total light intensity generated by the light-emitting unit remains essentially unchanged while the diffused light color temperature is accordingly adjusted to the higher diffused light color temperature;

wherein the first LED load and the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with a power level setting of the at least one DC power an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

57. The LED lighting device configured with a tunable diffused light color temperature according to claim **56**, wherein the at least one power source is an AC power source.

58. The LED lighting device configured with a tunable diffused light color temperature according to claim **56**, wherein the light-emitting unit is turned on by a power switch.

59. The LED lighting device configured with a tunable diffused light color temperature according to claim **56**, wherein the at least one power source is a DC power source, wherein the switching circuitry comprises a constant current circuitry outputting a constant current power.

60. The LED lighting device configured with a tunable diffused light color temperature according to claim **56**, wherein the light-emitting unit is turned on by a photo sensor and/or a motion sensor.

61. The LED lighting device configured with a tunable diffused light color temperature according to claim **56**, wherein the light-emitting unit is turned on by a wireless external control signal received from a wireless remote control device, a smart phone or a smart speaker.

62. The LED lighting device configured with a tunable diffused light color temperature according to claim **56**, wherein the controller is designed with a diffused light color temperature switching scheme comprising a plurality of different diffused light color temperature performances to be respectively activated by the at least one first external control signal generated by the first external control device, wherein different paired combinations of the first conduction rate and the second conduction rate respectively for controlling the first electric power delivered to the first LED load and the second electric power delivered to the second LED load for creating different diffused light color temperatures are preprogrammed and executed by the controller for operating a pick and play process according to the at least one first external control signal generated by the first external control device for selecting a corresponding diffused light color temperature performance in the diffused light color temperature switching scheme.

63. The LED lighting device configured with a tunable diffused light color temperature according to claim **62**, wherein the at least one first external control signal is a short power interruption signal generated by operating a main power switch, a push button, a touch sensor or a wireless remote control device wherein a power interruption detection circuit is electrically coupled with the controller, wherein when the short power interruption signal is detected by the power interruption detection circuit, the controller operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to a prearranged sequence.

64. The LED lighting device configured with a tunable diffused light color temperature according to claim **63**, wherein when the main power switch is used for generating the short power interruption signal, the main power switch is turned off and turned back on within a predetermined time interval.

65. The LED lighting device configured with a tunable diffused light color temperature according to claim **63**, wherein when the push button or the touch sensor is used, a signal detection circuitry is connected to the push button switch or the touch sensor, wherein when the push button or the touch sensor is operated, a voltage signal is transmitted to the signal detection circuitry to actuate a momentary power interruption and consequently the short power interruption signal is generated and detected by the power interruption detection circuit, the controller accordingly operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to the prearranged sequence.

66. The LED lighting device configured with a tunable diffused light color temperature according to claim **62**, wherein the first external control device is a voltage divider operated by a user to output a plurality of voltage signals interpretable by the controller for executing the pick and play process for respectively selecting and performing the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme; wherein the voltage divider is configured to output the plurality of voltage signals respectively represented by a voltage value, wherein the controller operates to activate the diffused light color temperature switching scheme to generate a corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to the voltage value outputted by the voltage divider.

67. The LED lighting device configured with a tunable diffused light color temperature according to claim **66**, wherein the voltage divider is operated with a configuration of a slide switch, a rotary switch, or a pull chain switch, designed with a plurality of switching positions operable by a user for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

68. The LED lighting device configured with a tunable diffused light color temperature according to claim **62**, wherein the first external control device is a wireless remote control device comprising at least one wireless external signal receiver electrically coupled with the controller to receive at least one wireless external control signal and convert the at least one wireless external control signal into the at least one first external control signal interpretable by the controller for activating the pick and play process to

select and perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme.

69. The LED lighting device configured with a tunable diffused light color temperature according to claim 62, wherein the first external control device is an active infrared ray sensor for detecting an infrared light reflected from an object and converting the infrared light reflected from the object into the at least one first external control signal interpretable by the controller for executing the pick and play process for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

70. The LED lighting device configured with a tunable diffused light color temperature according to claim 62, wherein the diffused light color temperature switching scheme comprises at least a high diffused light color temperature performance and a low diffused light color temperature performance, wherein for performing the high diffused light color temperature performance the second semiconductor switching device is fully conducted and the first semiconductor switching device is completely cut off, wherein for performing the low diffused light color temperature performance the first semiconductor switching device is fully conducted and the second semiconductor switching device is completely cut off.

71. The LED lighting device configured with a tunable diffused light color temperature according to claim 62, wherein the light color temperature switching scheme comprises at least a high diffused light color temperature performance, at least a medium diffused light color temperature performance and at least a low diffused light color temperature performance; wherein for performing the high diffused light color temperature performance the second semiconductor switching device is fully conducted and the first semiconductor switching device is completely cut off, wherein for performing the medium diffused light color temperature the first semiconductor switching device and the second semiconductor switching device are partially and complementarily conducted such that the total light intensity generated by the light-emitting unit remains essentially unchanged, wherein for performing the low diffused light color temperature performance the first semiconductor switching device is fully conducted while the second semiconductor switching device is completely cut off.

72. The LED lighting device configured with a tunable diffused light color temperature according to claim 71, wherein the controller is further designed with a free running process to operate a free running performance of the diffused light color temperature switching scheme, wherein a second external control device is designed to output a second external control signal to activate the free running process, wherein the controller manages to operate the free running process to gradually rotate a running pick and play of the diffused light color temperature switching scheme, wherein the free running process operates to perform the low diffused light color temperature performance first for a predetermined short time interval, and then is switched to perform the medium diffused light color temperature performance for the predetermined short time interval, and then is switched to perform the high diffused light color temperature performance for the predetermined short time interval to complete a free running cycle, the free running cycle continues till the second external control signal is ceased or till the second external control device outputs another second external control signal to end the free running process.

73. The LED lighting device configured with a tunable diffused light color temperature according to claim 62, wherein the at least one external control device is a push button or a touch sensor, wherein when the push button or the touch sensor is operated the controller accordingly operates to activate the pick and play process to alternately perform one of the diffused light color temperatures in the diffused light color temperature switching scheme according to a prearranged sequence.

74. The LED lighting device configured with a tunable diffused light color temperature according to claim 62, wherein the at least one external control device is a selection switch electrically connectable to a plurality of switching positions with each switching position being electrically and respectively coupled with a control pin of the controller, wherein when the selection switch is connected to one of the plurality of switching positions a constant voltage signal is delivered to a corresponding control pin of the controller to activate the diffused light color temperature switching scheme for selecting the corresponding diffused light color temperature.

75. The LED lighting device configured with a tunable diffused light color temperature according to claim 56, wherein M is equal to N.

76. The LED lighting device configured with a tunable diffused light color temperature according to claim 56, wherein M is smaller than N.

77. The LED lighting device configured with a tunable diffused light color temperature according to claim 56, wherein the low color temperature is designed in a range between 2000 K and 3000 K, the high color temperature is designed in the range between 5000 K and 6500K.

78. The LED lighting device configured with a tunable diffused light color temperature according to claim 56, wherein the LED lighting device is an LED light bulb, an LED recessed light, an LED ceiling light, an LED pendant light, an LED wall light, an LED under cabinet light, a ceiling fan light kit, a portable LED lamp or any other LED lamp for indoor or outdoor application.

79. The LED lighting device configured with a tunable diffused light color temperature according to claim 56, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first LED load and the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

80. The LED lighting device configured with a tunable diffused light color temperature according to claim 79, wherein when the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts, the first LED load and the second LED load are required to operate with respective working voltages V_N and V_M confined in domains expressed by $N_S\times2.5$ volts$<V_N<N_S\times3.5$ volts and $M_S\times2.5$ volts$<V_M<M_S\times3.5$ volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first LED load and the second LED load, wherein $N_S\leq N$ and $M_S\leq M$.

81. An LED lighting device comprising:

a light-emitting unit comprising a plurality of LEDs divided into two LED loads connected in parallel, including a first LED load with N number of LEDs emitting light with a low light color temperature and a second LED load with M number of LEDs emitting light with a high light color temperature, wherein M and N are positive integers;

a light diffuser covering the first LED load and the second LED load to create a diffused light with a diffused light color temperature;

an LED driver circuitry electrically coupled between a power source

and the light-emitting unit to output a DC power;

a loading and power control unit configured with at least a power loading circuitry electrically coupled between the LED driver circuitry and the light-emitting unit to operate a plurality of different power loading options for respectively distributing and loading the DC power between a first electric power delivered to the first LED load and a second electric power delivered to the second LED load, wherein each of the plurality of different power loading options is configured with a paired combination of the first electric power and the second electric power for generating the diffused light with the diffused light color temperature to form a diffused light color temperature switching scheme comprising a plurality of different diffused light color temperature performances for selection; and

an external control unit including at least a first external control device for activating the diffused light color temperature switching scheme and executing a power loading option for performing a corresponding diffused light color temperature performance;

wherein the N number LEDs of the first LED load and the M number LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with a power level setting of the DC power an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

82. The LED lighting device according to claim **81**, wherein the low light color temperature is designed in a range between 2000 K and 3000 K, wherein the high light color temperature is designed in a range between 5000 K and 6500 K.

83. The LED lighting device according to claim **81**, wherein the power loading circuitry comprises a controller, a first semiconductor switching device and a second semiconductor switching device; wherein the controller is electrically coupled with the first semiconductor switching device, the second semiconductor switching device and the first external control device; wherein the first semiconductor switching device is electrically connected in series between the LED driver circuitry and the first LED load and the second semiconductor switching device is electrically connected in series between the LED driver circuitry and the second LED load; wherein the first external control device outputs at least one first external control signal to activate the diffused light color temperature switching scheme;

wherein the controller outputs a first control signal to control a first conduction rate of the first semiconductor switching device and a second control signal to control a second conduction rate of the second semiconductor switching device to respectively deliver the first electric power to the first LED load and the second electric power to the second LED load; wherein the controller is designed to operate the plurality of different power loading options, wherein different paired combinations of the first conduction rate and the second conduction rate respectively for controlling the first electric power delivered to the first LED load and the second electric power delivered to the second LED load for creating different diffused light color temperatures are preprogrammed and addressable by the controller for operating a pick and play process according to the at least one first external control signal generated by the first external control device for selecting the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme; wherein a total light intensity generated by the light-emitting unit remains essentially unchanged while the diffused light color temperature is alternately adjusted.

84. The LED lighting device according to claim **83**, wherein the at least one first external control signal is a short power interruption signal generated by operating a main power switch, a push button, a touch sensor or a wireless remote control device, wherein a power interruption detection circuit is electrically coupled with the controller, wherein when the short power interruption signal is detected by the power interruption detection circuit, the controller operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to a prearranged sequence.

85. The LED lighting device according to claim **84**, wherein when the main power switch is used for generating the short power interruption signal, the main power switch is turned off and turned back on within a predetermined time interval.

86. The LED lighting device according to claim **84**, wherein when the push button or the touch sensor is used, a signal detection circuitry is connected to the push button or the touch sensor, wherein when the push button or the touch sensor is operated, a voltage signal is transmitted to the signal detection circuitry to actuate a momentary power interruption and consequently a short power interruption signal is generated and detected by the power interruption detection circuit, the controller accordingly operates to alternately perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to a prearranged sequence.

87. The LED lighting device according to claim **84**, wherein the short power interruption signal is generated by a wireless external control signal designed to control a conduction state of a bi-directional semiconductor switching device electrically connected between an AC power source and an LED driver circuitry, wherein the wireless external control signal is received by a wireless signal receiver electrically coupled with a second controller electrically coupled with the bi-directional semiconductor switching device, wherein upon receiving the wireless external control signal the second controller operates to instantly cutoff a conduction of the bi-directional semiconductor switching device and re-conduct the bi-directional semiconductor switching device within a predetermined time interval, wherein the LED driver circuitry comprises an AC/DC

power converter and a constant current control circuit to output a constant current to the power loading circuitry.

88. The LED lighting device according to claim **84**, wherein the short power interruption signal is generated by a push button or a touch sensor electrically coupled with a second controller electrically coupled with a bi-directional semiconductor switching device to control a conduction state of the bi-directional semiconductor switching device electrically connected between an AC power source and an LED driver circuitry, wherein when the push button or the touch sensor is operated for a short time interval, a voltage signal with a time length equal to the short time interval is detected by the second controller, wherein upon receiving the voltage signal the second controller operates to instantly cutoff a conduction of the bi-directional semiconductor switching device and re-conduct the bi-directional semiconductor switching device within the short time interval to generate the short power interruption signal, wherein the LED driver circuitry comprises an AC/DC power converter and a constant current control circuit to output a constant current to the power loading circuitry.

89. The LED lighting device according to claim **83**, wherein the first external control device is a voltage divider operated by a user to output a plurality of voltage signals interpretable by the controller for respectively executing the pick and play process for respectively selecting and performing the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme; wherein the voltage divider is configured to output the plurality of voltage signals respectively represented by a voltage value, wherein the controller operates to activate the diffused light color temperature switching scheme to generate a corresponding diffused light color temperature performance in the diffused light color temperature switching scheme according to the voltage value outputted by the voltage divider.

90. The LED lighting device according to claim **89**, wherein the voltage divider is optionally designed with a stepless/free setting switch; wherein the voltage divider is configured to operate with a variable resistor to output a voltage value corresponding to a final parking location of a switching motion at the variable resistor; wherein a full voltage value of the voltage divider corresponding to a full length of the variable resistor is divided into a plurality of different voltage domains for activating the pick and play process, wherein the stepless/free setting switch is allowed to park at any location on the variable resistor to generate a corresponding voltage value to the controller, wherein the controller is designed to operate the pick and play process according to a belonging of a voltage domain with respect to the corresponding voltage value received from the voltage divider for selecting the diffused light color temperature performance corresponding to the voltage domain.

91. The LED lighting device according to claim **89**, wherein the voltage divider is operated with a configuration of a slide switch, a rotary switch, or a pull chain switch, designed with a plurality of switching positions operable by a user for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

92. The LED lighting device according to claim **83**, wherein the first external control device is a wireless remote control device comprising at least one wireless external signal receiver electrically coupled with the controller to receive at least one wireless external control signal and convert the at least one wireless external control signal into the at least one first external control signal interpretable by the controller for activating the pick and play process to select and perform the corresponding diffused light color temperature performance in the diffused light color temperature switching scheme.

93. The LED lighting device according to claim **83**, wherein the first external control device is an active infrared ray sensor for detecting an infrared light reflected from an object and converting the infrared light reflected from the object into the at least one first external control signal interpretable by the controller for executing the pick and play process for selecting and performing the corresponding diffused light color temperature performance from the diffused light color temperature switching scheme.

94. The LED lighting device according to claim **83**, wherein the at least one external control device is a push button or a touch sensor, wherein when the push button or the touch sensor is operated, the controller accordingly operates to activate the pick and play process to alternately perform one of the diffused light color temperature performances in the diffused light color temperature switching scheme according to a prearranged sequence.

95. The LED lighting device according to claim **83**, wherein the at least one external control device is a selection switch electrically connectable to a plurality of switching positions with each switching position being electrically and respectively coupled with a control pin of the controller, wherein when the selection switch is connected to one of the plurality of switching positions, a constant voltage signal is delivered to a corresponding control pin of the controller to activate the diffused light color temperature switching scheme for selecting the corresponding diffused light color temperature performance.

96. The LED lighting device according to claim **83**, wherein the LED lighting device is an LED light bulb, an LED recessed light, an LED ceiling light, an LED pendant light, an LED wall light, an LED under cabinet light, a ceiling fan light kit, a portable LED lamp or any other LED lamp for indoor or outdoor application.

97. The LED lighting device according to claim **83**, wherein the diffused light color temperature performances of the diffused light color temperature switching scheme include a low diffused light color temperature performance, a medium diffused light color temperature performance and a high diffused light color temperature performance; wherein the controller is further designed with a free running process to operate a free running performance of the diffused light color temperature switching scheme, wherein a second external control device is designed to output a second external control signal to activate the free running process, wherein the controller manages to operate the free running process to gradually rotate a running pick and play of the diffused light color temperature switching scheme, wherein the free running process operates to perform the low diffused light color temperature performance first for a predetermined short time interval, and then is switched to perform the medium diffused light color temperature performance for the predetermined short time interval, and then is switched to perform the high diffused light color temperature performance for the predetermined short time interval to complete a free running cycle, the free running cycle continues till the second external control signal is ceased or till the second external control device outputs another second external control signal to end the free running process.

98. The LED lighting device according to claim **83**, wherein the diffused light color temperature performances of the diffused light color temperature switching scheme include a low diffused light color temperature performance,

a low-medium diffused light color temperature performance, a medium diffused light color temperature performance, a high-medium diffused light color temperature performance and a high diffused light color temperature performance; wherein the controller is further designed with a free running process to operate a free running performance of the diffused light color temperature switching scheme, wherein a second external control device is designed to output a second external control signal to activate the free running process, wherein the controller manages to operate the free running process to gradually rotate a running pick and play of the diffused light color temperature switching scheme, wherein the free running process operates to perform the low diffused light color temperature performance first for a predetermined short time interval, and then is switched to perform the low-medium diffused light color temperature performance for the predetermined short time interval, and then is switched to perform the medium diffused light color temperature performance for the predetermined short time interval, and then is switched to perform the high-medium diffused light color temperature performance for the predetermined short time interval, and then is switched to perform the high diffused light color temperature performance to complete a free running cycle, the free running cycle continues till the second external control signal is ceased or till the second external control device outputs another second external control signal to end the free running process.

99. The LED lighting device according to claim **81**, wherein the first external control device comprises a selection switch respectively connectable to two switching positions configured in the power loading circuitry including a first switching position electrically connected to the first LED load and a second switching position electrically connected to the second LED load, wherein the power loading circuitry is designed with two power loading options including a first power loading option and a second power loading option, wherein when the selection switch is electrically connected to the first switching position, the first power loading option is activated with the DC power being delivered only to the first LED load, namely the first electric power is equal to the DC power, to generate the diffused light with a low diffused light color temperature, and wherein when the selection switch is electrically connected to the second switching position, the second power loading option is activated with the DC power being delivered only to the second LED load, namely the second electric power is equal to the DC power, to generate the diffused light with a high diffused light color temperature.

100. The LED lighting device according to claim **81**, wherein the LED driver circuitry outputs the DC power with a constant current to the light-emitting unit; wherein the first external control device comprises a selection switch connectable respectively to three switching positions configured in the power loading circuitry including a first switching position electrically connected to only the first LED load, a second switching position electrically connected to both the first LED load and the second LED load, and a third switching position electrically connected to only the second LED load; wherein the power loading circuitry comprises three power loading options including a first power loading option, a second power loading option and a third power loading option; wherein when the selection switch is electrically connected to the first switching position, the first power loading option is activated with the DC power being delivered only to the first LED load, namely the first electric power is equal to the DC power, to generate the diffused light with a low diffused light color temperature; wherein when the selection switch is electrically connected to the second switching position, the second power loading option is activated with the DC power being delivered to both the first LED load and the second LED load to generate the diffused light with a medium diffused light color temperature; wherein when the selection switch is electrically connected to the third switching position, the third power loading option is activated with the DC power being delivered only to the second LED load, namely the second electric power is equal to the DC power, to generate the diffused light with a high diffused light color temperature.

101. The LED lighting device according to claim **81**, wherein the LED driver circuitry outputs the DC power with a constant current to the light-emitting unit; wherein the first external control device comprises a selection switch connectable respectively to five switching positions configured in the power loading circuitry including a first switching position electrically connected to only the first LED load, a second switching position electrically connected to both the first LED load and the second LED load with a second resistor being connected in series with the second LED load, a third switching position electrically connected to both the first LED load and the second LED load, a fourth switching position electrically connected with both the first LED load and the second LED load with a first resistor being connected in series with the first LED load, and a fifth switching position electrically connected to only the second LED load, wherein the power loading circuitry comprises five power loading options including a first power loading option, a second power loading option, a third power loading option, a fourth power loading option and a fifth power loading option; wherein when the selection switch is electrically connected to the first switching position, the first power loading option is activated with the DC power being delivered only to the first LED load with the first electric power being equal to the DC power to generate the diffused light with a low diffused light color temperature; wherein when the selection switch is electrically connected to the second switching position, the second power loading option is activated with the DC power being delivered to both the first LED load and the second LED load with the first electric power delivered to the first LED load being greater than the second electric power delivered to the second LED load to generate the diffused light with a low-medium diffused light color temperature; wherein when the selection switch is electrically connected to the third switching position, the third power loading option is activated with the DC power being distributed to both the first LED load and the second LED load with the first electric power being essentially equal to the second electric power to generate the diffused light with a medium diffused light color temperature; wherein when the selection switch is electrically connected to the fourth switching position, the fourth power loading option is activated with the DC power being distributed between the first LED load and the second LED load with the second electric power delivered to the second LED load being greater than the first electric power delivered to the first LED load to generate the diffused light with a high-medium diffused light color temperature, and when the selection switch is electrically connected to the fifth switching position, the fifth power loading option is activated with the DC power being delivered to only the second LED load with the second electric power being equal to the DC power to generate the diffused light with a high diffused light color temperature.

* * * * *

EXHIBIT I

US010154564B2

(12) **United States Patent**
Chen

(10) **Patent No.: US 10,154,564 B2**
(45) **Date of Patent: *Dec. 11, 2018**

(54) **APP BASED FREE SETTING METHOD FOR SETTING OPERATING PARAMETER OF SECURITY LIGHT**

(71) Applicant: **Chia-Teh Chen**, Taipei (TW)

(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 134 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/255,493**

(22) Filed: **Sep. 2, 2016**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 15/072,602, filed on Mar. 17, 2016, now Pat. No. 9,560,719, (Continued)

(51) **Int. Cl.**
H05B 37/02 (2006.01)
H05B 33/08 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H05B 37/0218*** (2013.01); ***F04D 25/06*** (2013.01); ***F04D 25/088*** (2013.01); ***F04D 27/004*** (2013.01); ***F04D 29/005*** (2013.01); ***F04D 29/325*** (2013.01); ***F21V 33/0096*** (2013.01); ***G06F 3/04847*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H05B 37/0218; H05B 33/0815; H05B 33/0818; H05B 33/0824; H05B 33/0827; H05B 33/0854; H05B 33/0863; H05B 33/0872; H05B 37/0227; H05B 37/0272; H05B 37/0281; F04D 25/06; F04D 25/088; F04D 25/004; F04D 25/005; F04D 25/325; F21V 33/0096; G06F 3/04847; G06F 3/04883; G06F 3/04886; G08B 15/00;
(Continued)

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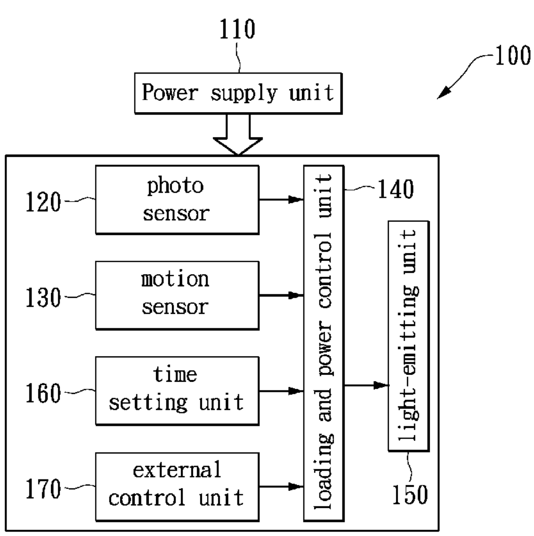
(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A lighting control system using an APP based software technology to operate on line free settings of various operating parameters for a lighting device including setting of manual override timer, setting of detection range of a motion sensor, setting of light-on duration activated by a motion sensor, setting of light intensities for various illumination modes and setting of light color temperature. The technology enables a user to set an operating parameter within a maximum capacity of a designed circuitry on an on line computing basis according to his or her lifestyle by operating an application program designed and loaded in a mobile phone. The technology of the present invention is applicable to a single level security light, a two level security light or a multi-level/life style security light with optional lighting source being a LED load, an incandescent load or any other electrically energize-able light emitting materials.

65 Claims, 19 Drawing Sheets



Related U.S. Application Data

which is a continuation of application No. 14/487,334, filed on Sep. 16, 2014, now Pat. No. 9,326,362, which is a continuation-in-part of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

(51) **Int. Cl.**

H05B 37/00	(2006.01)
G06F 7/06	(2006.01)
G09G 5/00	(2006.01)
G06F 17/00	(2006.01)
F21V 33/00	(2006.01)
G06F 3/0488	(2013.01)
G06F 3/0484	(2013.01)
F04D 25/08	(2006.01)
F04D 25/06	(2006.01)
F04D 27/00	(2006.01)
F04D 29/00	(2006.01)
F04D 29/32	(2006.01)
G08B 15/00	(2006.01)
F21Y 115/10	(2016.01)
G08B 13/189	(2006.01)

(52) **U.S. Cl.**
CPC ***G06F 3/04883*** (2013.01); ***G06F 3/04886*** (2013.01); ***G08B 15/00*** (2013.01); ***H05B 33/0815*** (2013.01); ***H05B 33/0818*** (2013.01); ***H05B 33/0824*** (2013.01); ***H05B 33/0827*** (2013.01); ***H05B 33/0854*** (2013.01); ***H05B 33/0863*** (2013.01); ***H05B 33/0872*** (2013.01); ***H05B 37/0227*** (2013.01); ***H05B 37/0272*** (2013.01); ***H05B 37/0281*** (2013.01); *F21Y 2115/10* (2016.08); *G08B 13/189* (2013.01); *Y02B 20/42* (2013.01); *Y02B 20/44* (2013.01); *Y02B 20/46* (2013.01)

(58) **Field of Classification Search**
CPC ... G08B 13/189; F21Y 2115/10; Y02B 20/42; Y02B 20/44; Y02B 20/46
USPC 315/290–311
See application file for complete search history.

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2006/0123053	A1 *	6/2006	Scannell, Jr.	G06F 17/30035

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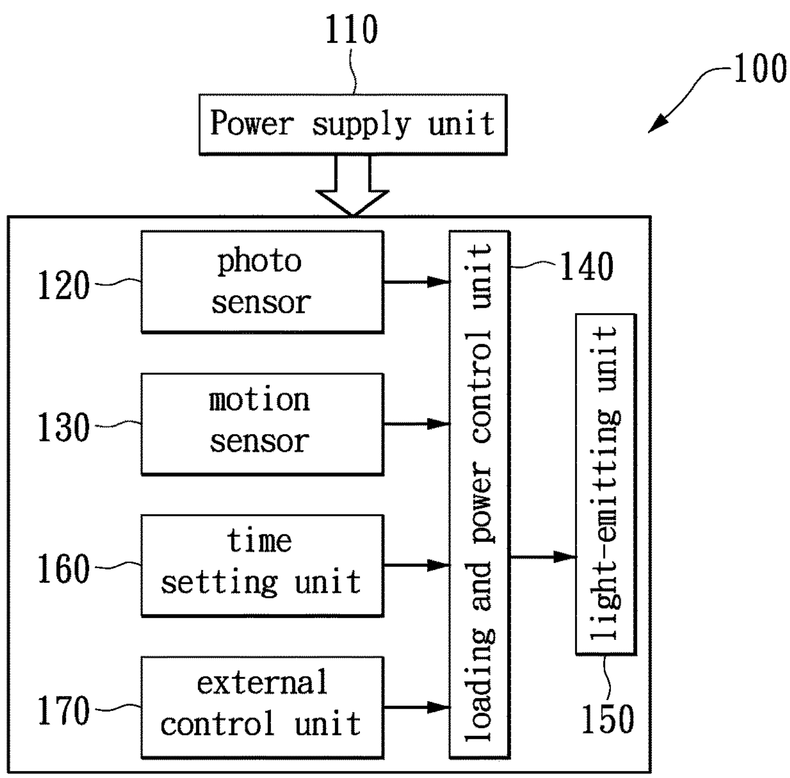

110
100
Power supply unit
120
photo sensor
130
motion sensor
160
time setting unit
170
external control unit
loading and power control unit
140
light-emitting unit
150

FIG. 1

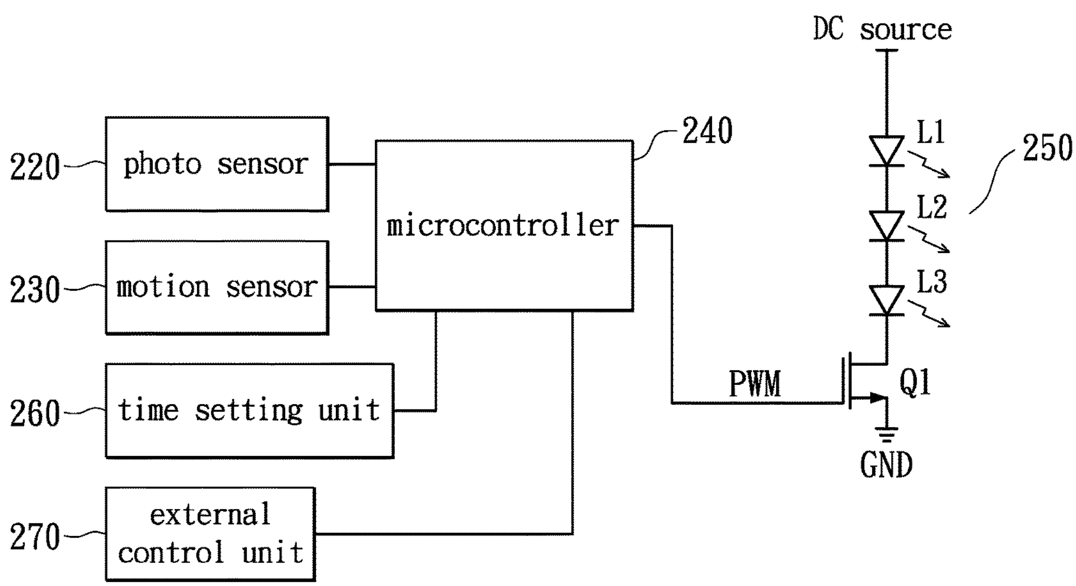

DC source
240
L1
250
L2
L3
220
photo sensor
microcontroller
230
motion sensor
260
time setting unit
PWM
Q1
GND
270
external control unit

FIG. 2A

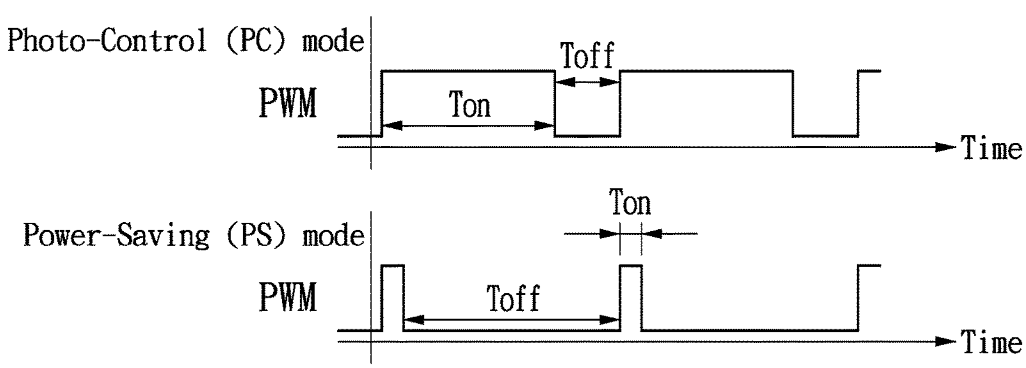
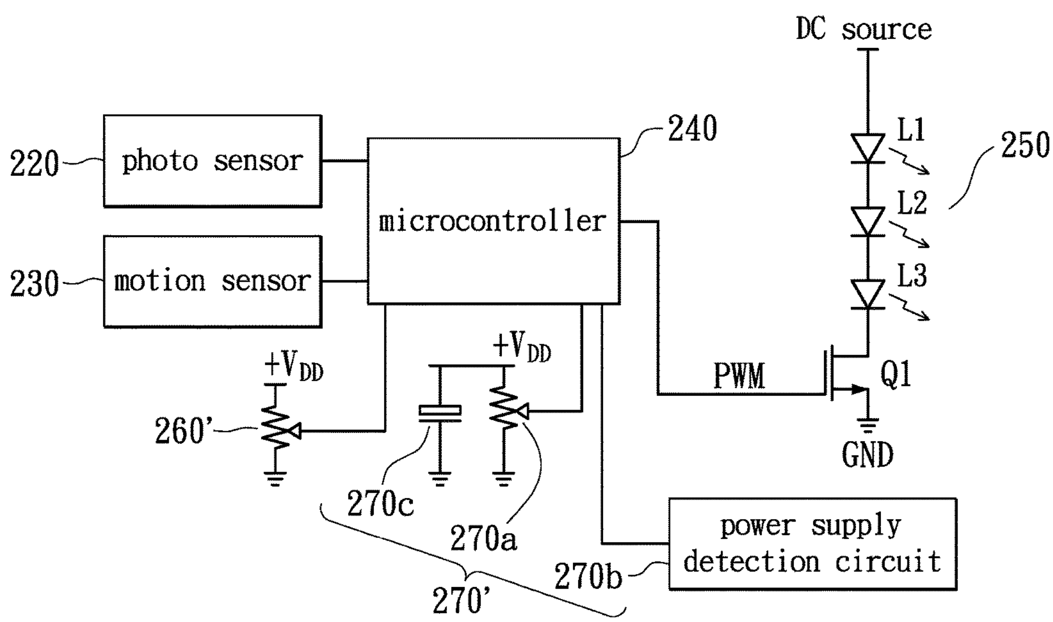


Photo-Control (PC) mode
Toff
PWM
Ton
Time
Ton
Power-Saving (PS) mode
PWM
Toff
Time

FIG. 2B



DC source
220
photo sensor
230
motion sensor
microcontroller
240
L1
L2
L3
250
PWM
Q1
GND
+VDD
260'
+VDD
270c
270a
270b
270'
power supply
detection circuit

FIG. 2C

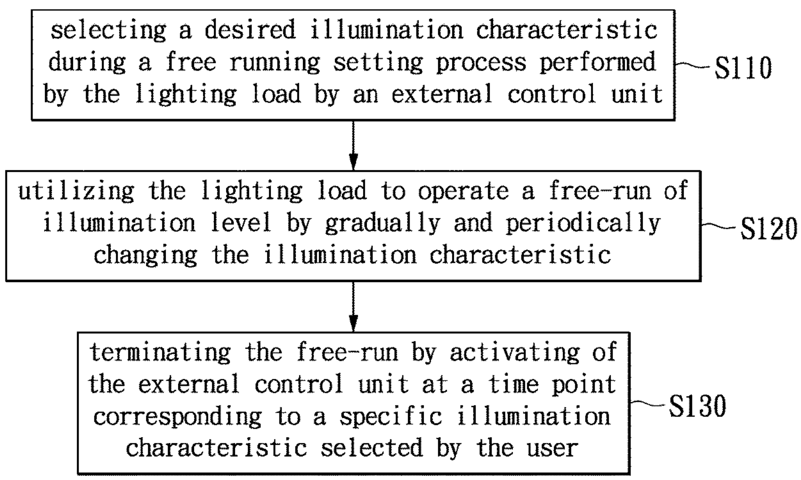

selecting a desired illumination characteristic during a free running setting process performed by the lighting load by an external control unit
S110
utilizing the lighting load to operate a free-run of illumination level by gradually and periodically changing the illumination characteristic
S120
terminating the free-run by activating of the external control unit at a time point corresponding to a specific illumination characteristic selected by the user
S130

FIG. 2D

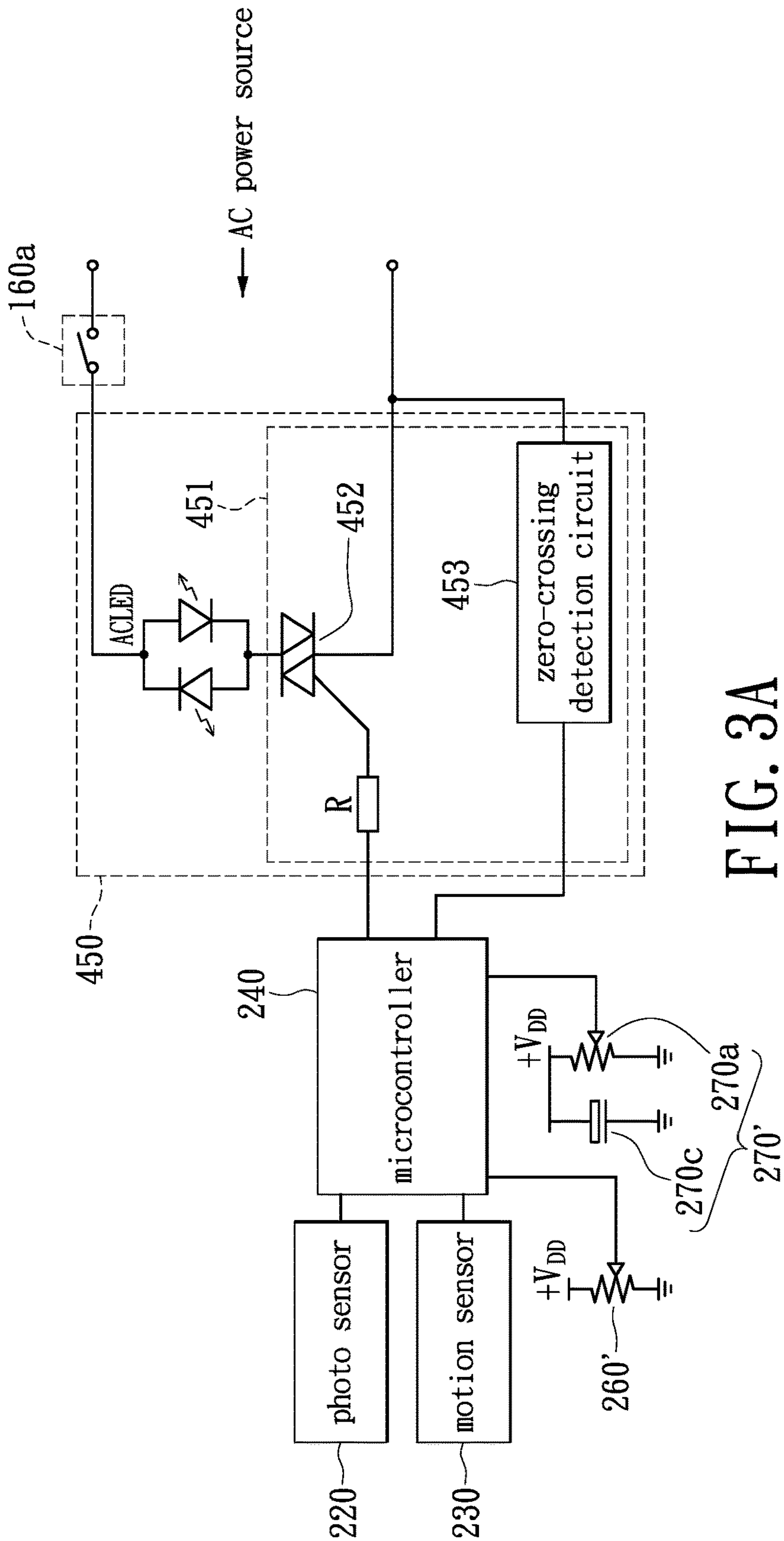

AC power source
160a
450
451
452
453
ACLED
R
zero-crossing detection circuit
240
microcontroller
+VDD
270a
270c
270'
260'
photo sensor
motion sensor
220
230

FIG. 3A

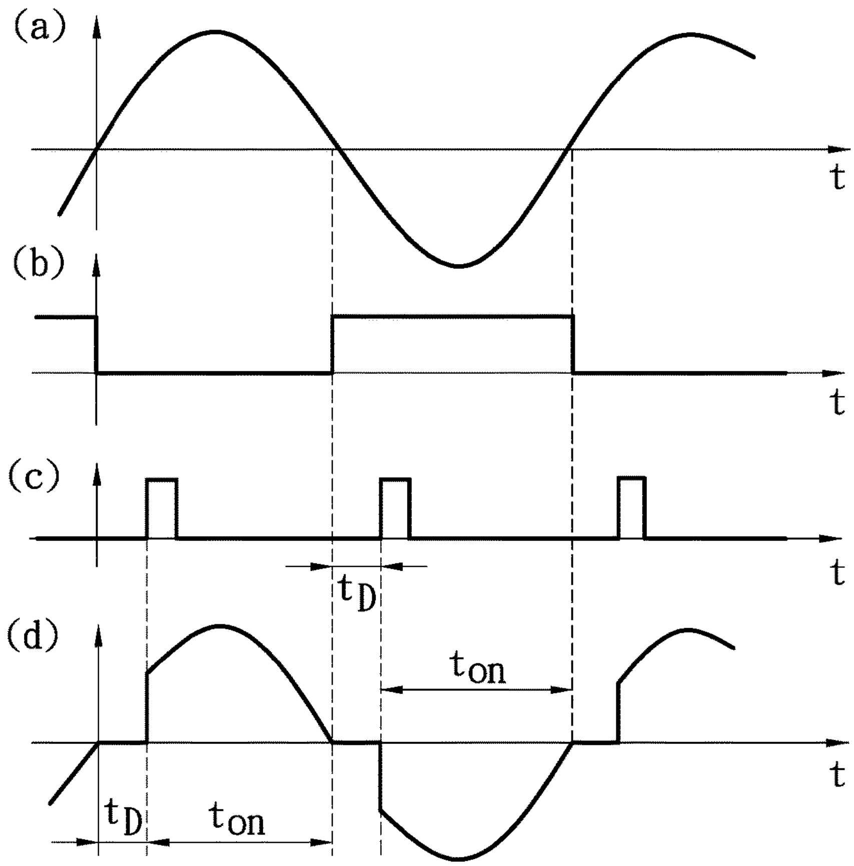


FIG. 3B

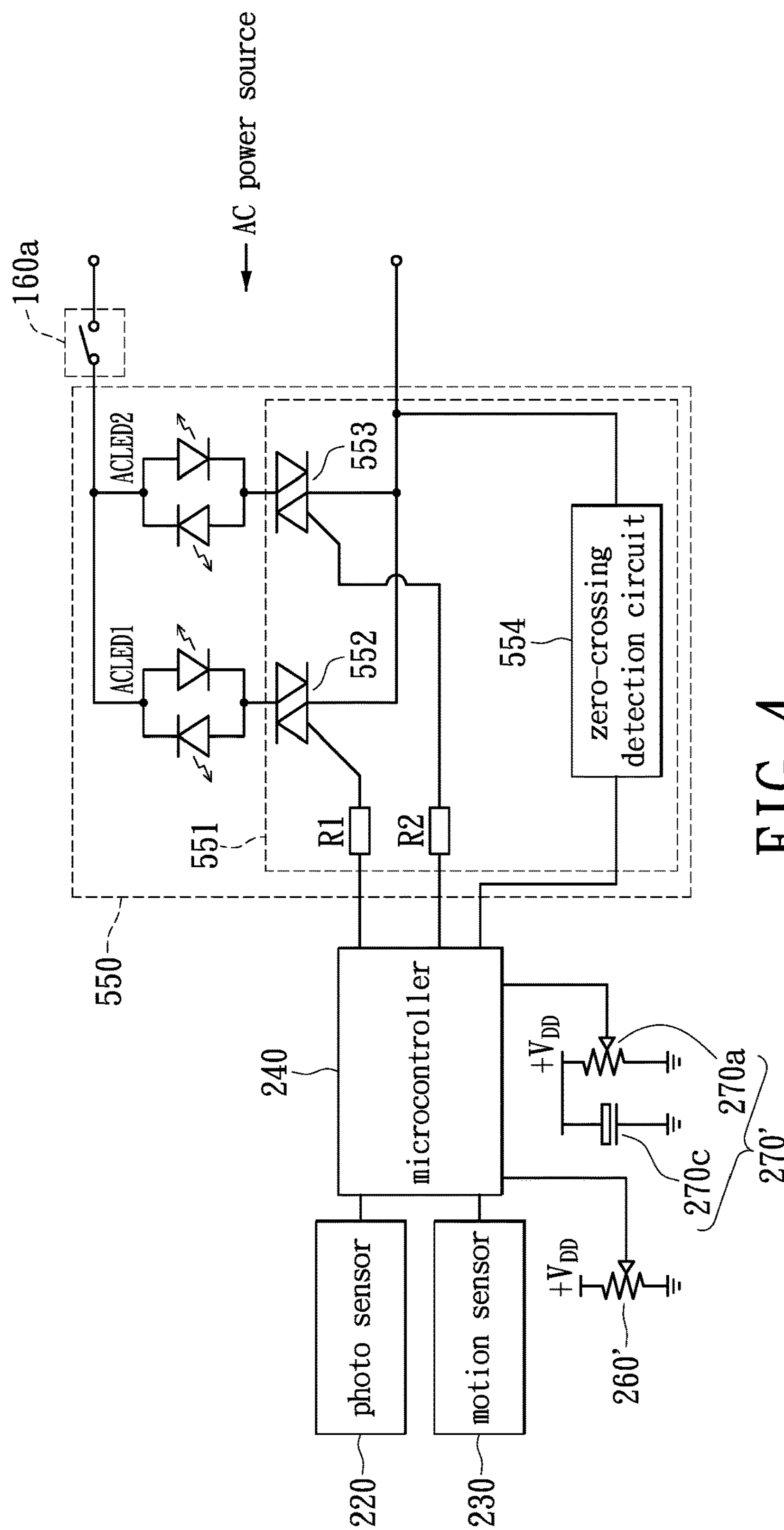

AC power source
160a
ACLED2
ACLED1
553
552
551
554
zero-crossing detection circuit
R1
R2
550
240
microcontroller
$+V_{DD}$
270a
270c
270'
photo sensor
motion sensor
$+V_{DD}$
260'
220
230

FIG. 4

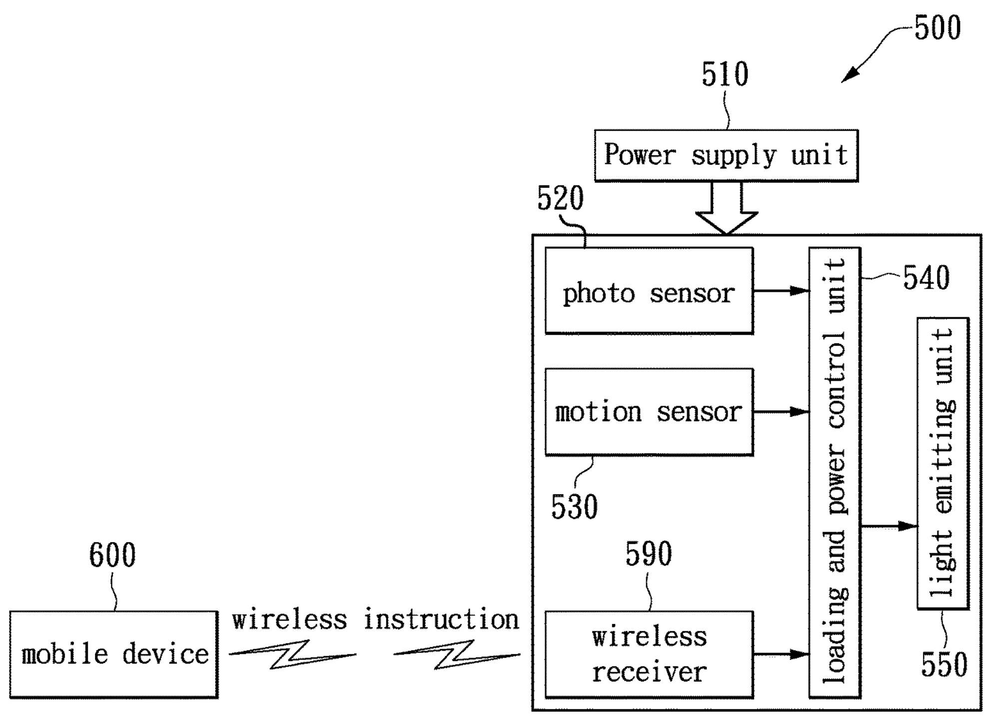

500
510
Power supply unit
520
photo sensor
motion sensor
530
loading and power control unit
540
light emitting unit
550
590
wireless receiver
600
mobile device
wireless instruction

FIG. 5

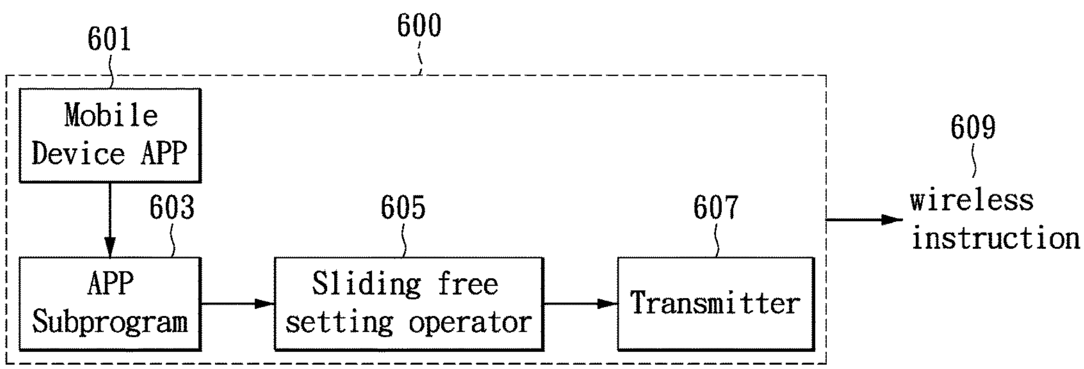

600
601
Mobile Device APP
603
APP Subprogram
605
Sliding free setting operator
607
Transmitter
609
wireless instruction

FIG. 6A

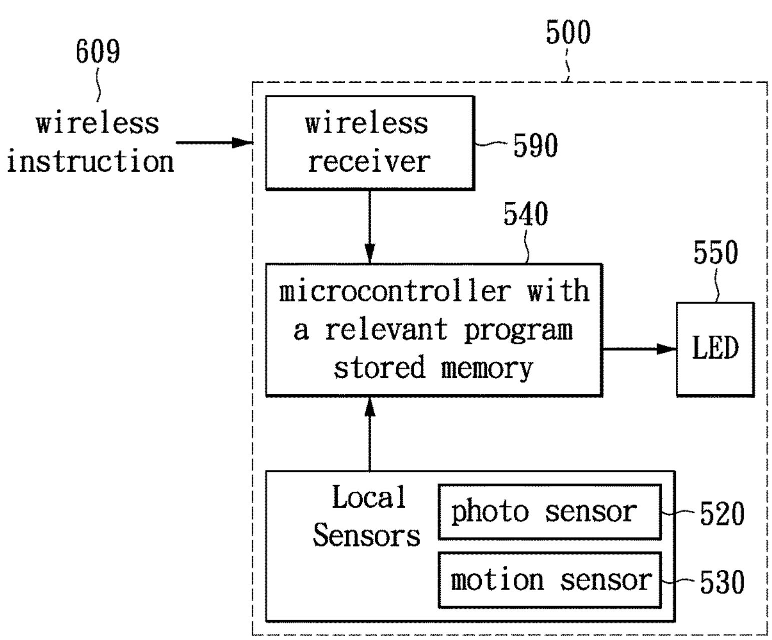

609
wireless instruction
500
wireless receiver
590
540
microcontroller with a relevant program stored memory
550
LED
Local Sensors
photo sensor
520
motion sensor
530

FIG. 6B

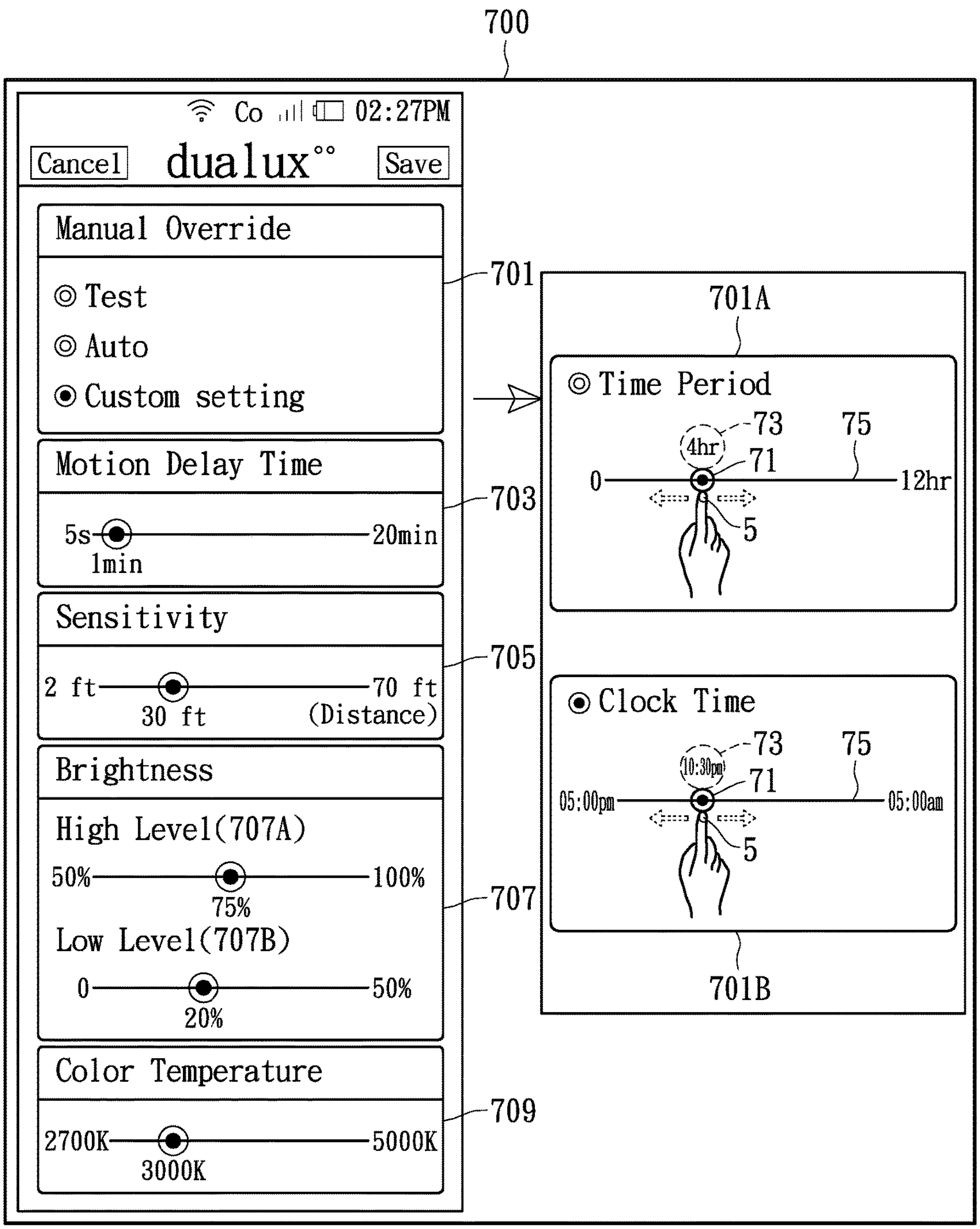

700
02:27PM
Cancel
dualux
Save
Manual Override
Test
Auto
Custom setting
701
Motion Delay Time
5s
1min
20min
703
Sensitivity
2 ft
30 ft
70 ft
(Distance)
705
Brightness
High Level(707A)
50%
75%
100%
Low Level(707B)
0
20%
50%
707
Color Temperature
2700K
3000K
5000K
709
701A
Time Period
73
75
4hr
71
0
12hr
5
Clock Time
73
75
10:30pm
71
05:00pm
05:00am
5
701B

FIG. 7

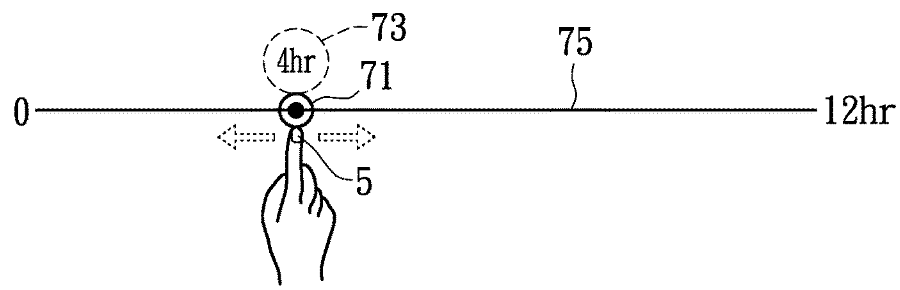


FIG. 7A

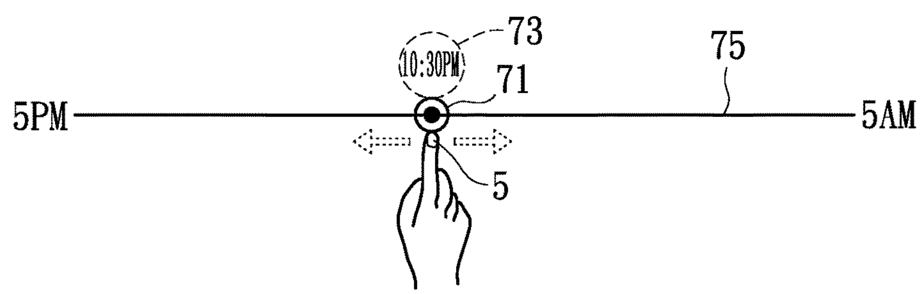


FIG. 7B

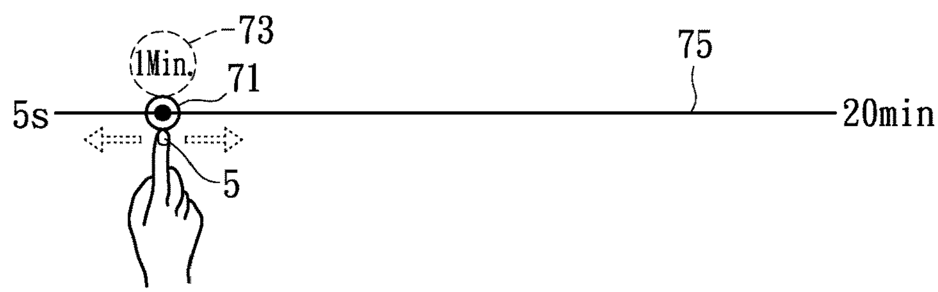


FIG. 7C

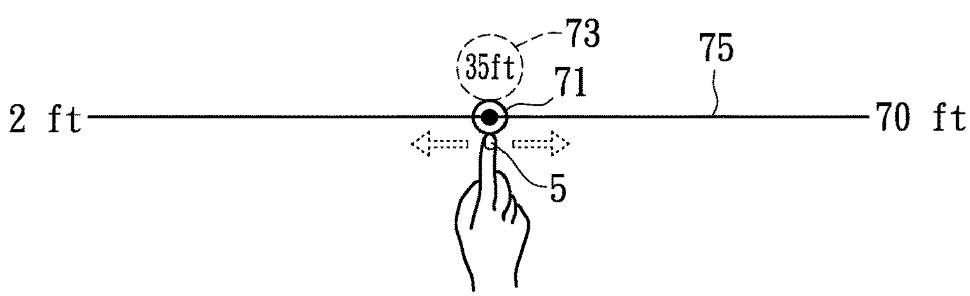


FIG. 7D

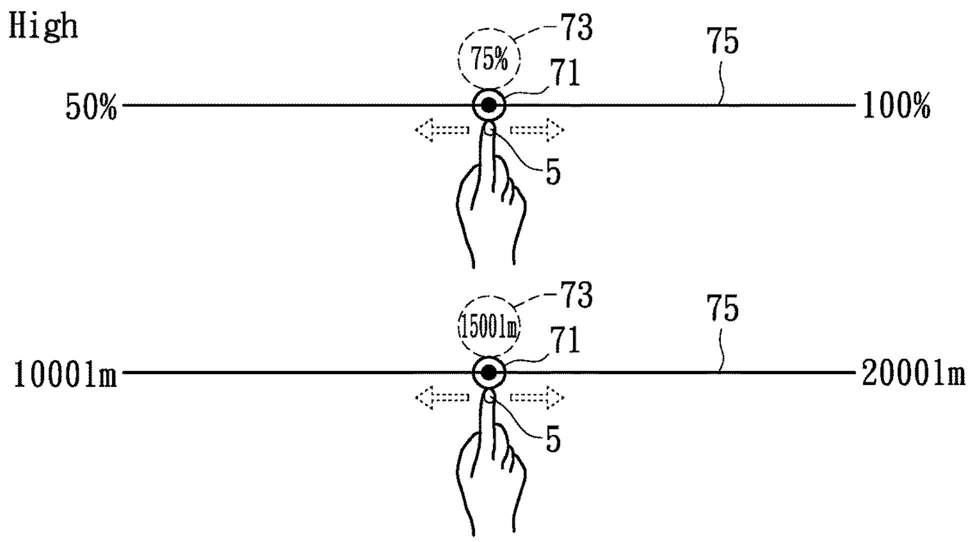


FIG. 7E

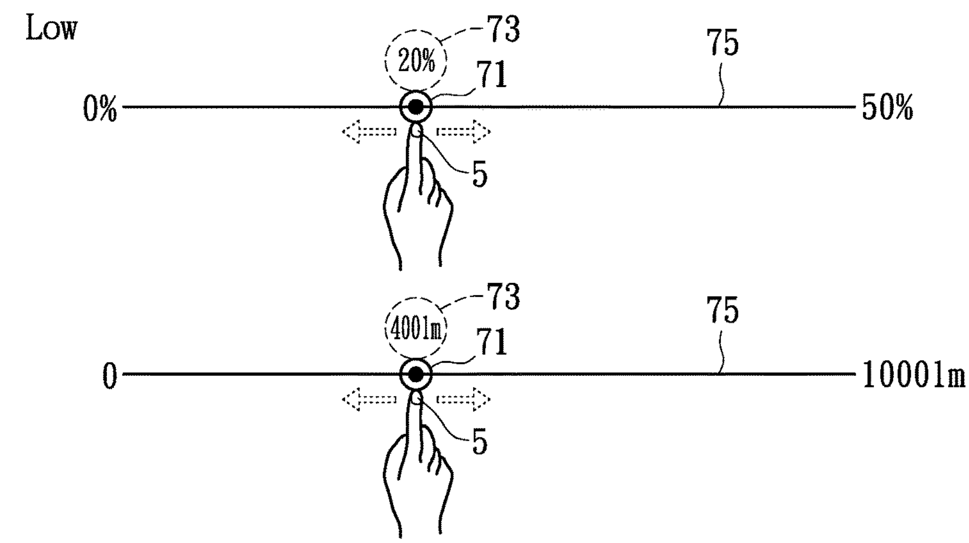


FIG. 7F

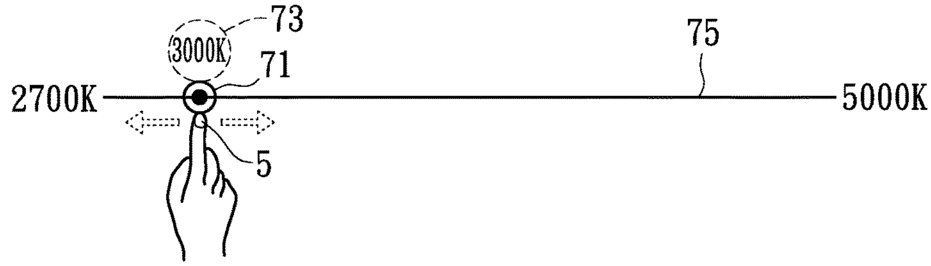


FIG. 7G

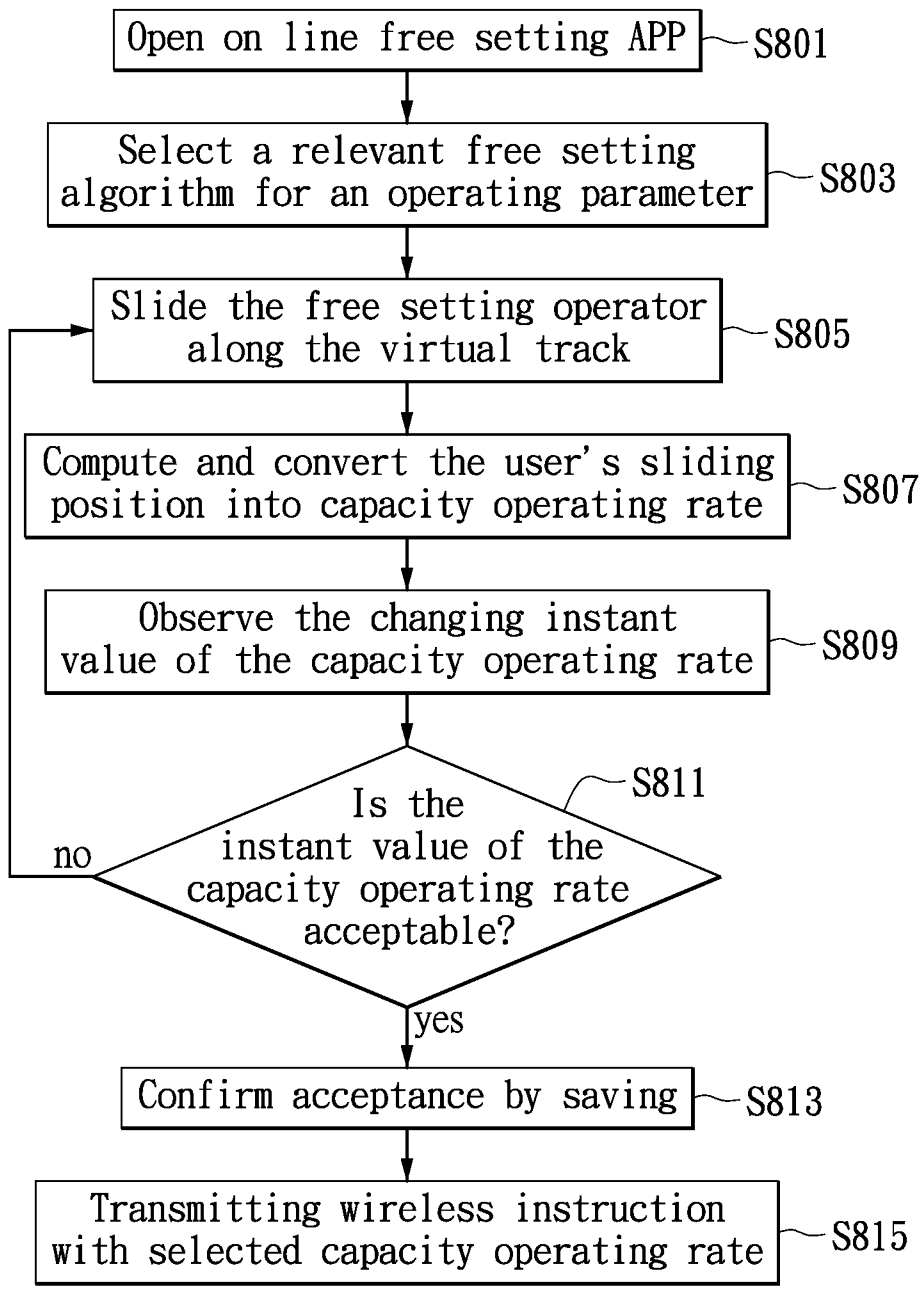

Open on line free setting APP
S801
Select a relevant free setting algorithm for an operating parameter
S803
Slide the free setting operator along the virtual track
S805
Compute and convert the user's sliding position into capacity operating rate
S807
Observe the changing instant value of the capacity operating rate
S809
Is the instant value of the capacity operating rate acceptable?
S811
no
yes
Confirm acceptance by saving
S813
Transmitting wireless instruction with selected capacity operating rate
S815

FIG. 8A

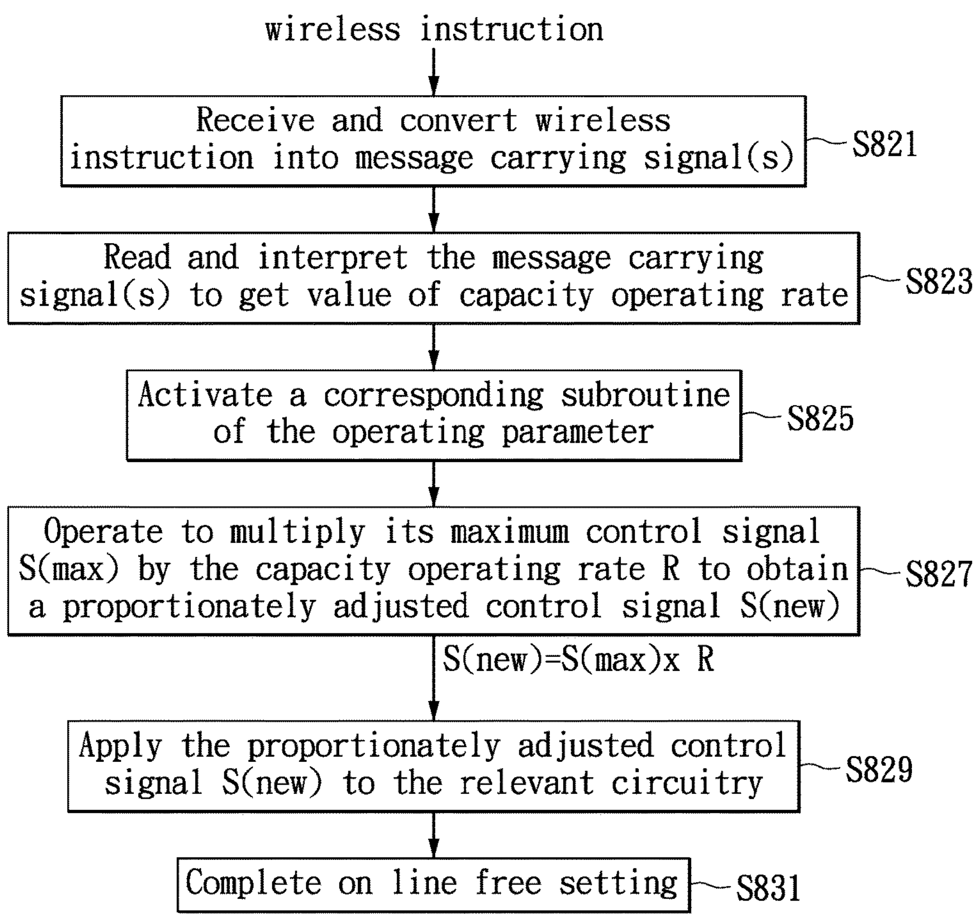

wireless instruction
Receive and convert wireless instruction into message carrying signal(s)
S821
Read and interpret the message carrying signal(s) to get value of capacity operating rate
S823
Activate a corresponding subroutine of the operating parameter
S825
Operate to multiply its maximum control signal S(max) by the capacity operating rate R to obtain a proportionately adjusted control signal S(new)
S827
S(new)=S(max)x R
Apply the proportionately adjusted control signal S(new) to the relevant circuitry
S829
Complete on line free setting
S831

FIG. 8B

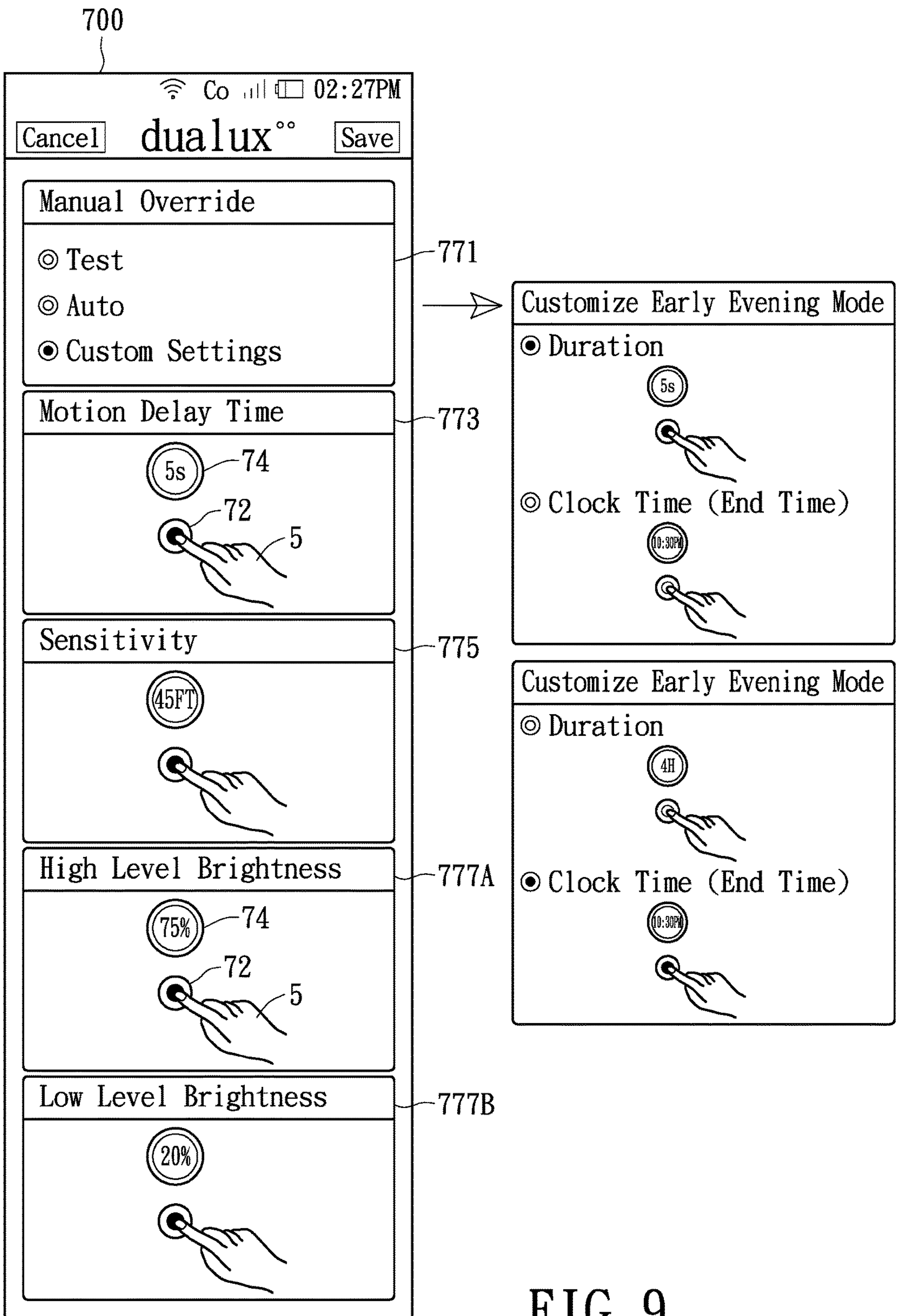

700
Co
02:27PM
Cancel
dualux
Save
Manual Override
Test
Auto
Custom Settings
771
Motion Delay Time
773
5s
74
72
5
Sensitivity
775
45FT
High Level Brightness
777A
75%
74
72
5
Low Level Brightness
777B
20%
Customize Early Evening Mode
Duration
5s
Clock Time (End Time)
10:30PM
Customize Early Evening Mode
Duration
4H
Clock Time (End Time)
10:30PM

FIG. 9

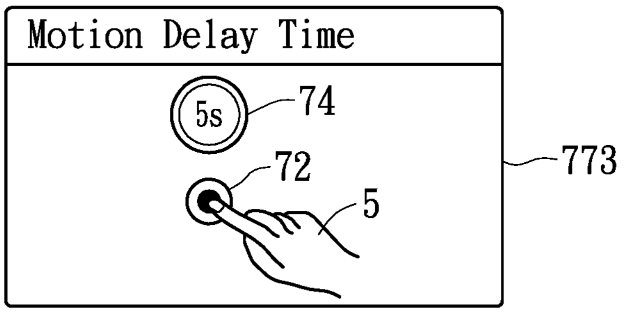

Motion Delay Time
5s
74
72
5
773

FIG. 9A

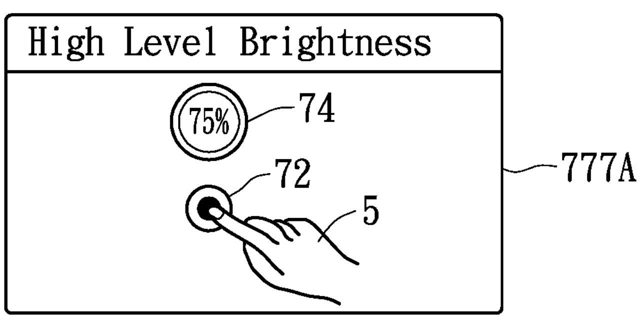

High Level Brightness
75%
74
72
5
777A

FIG. 9B

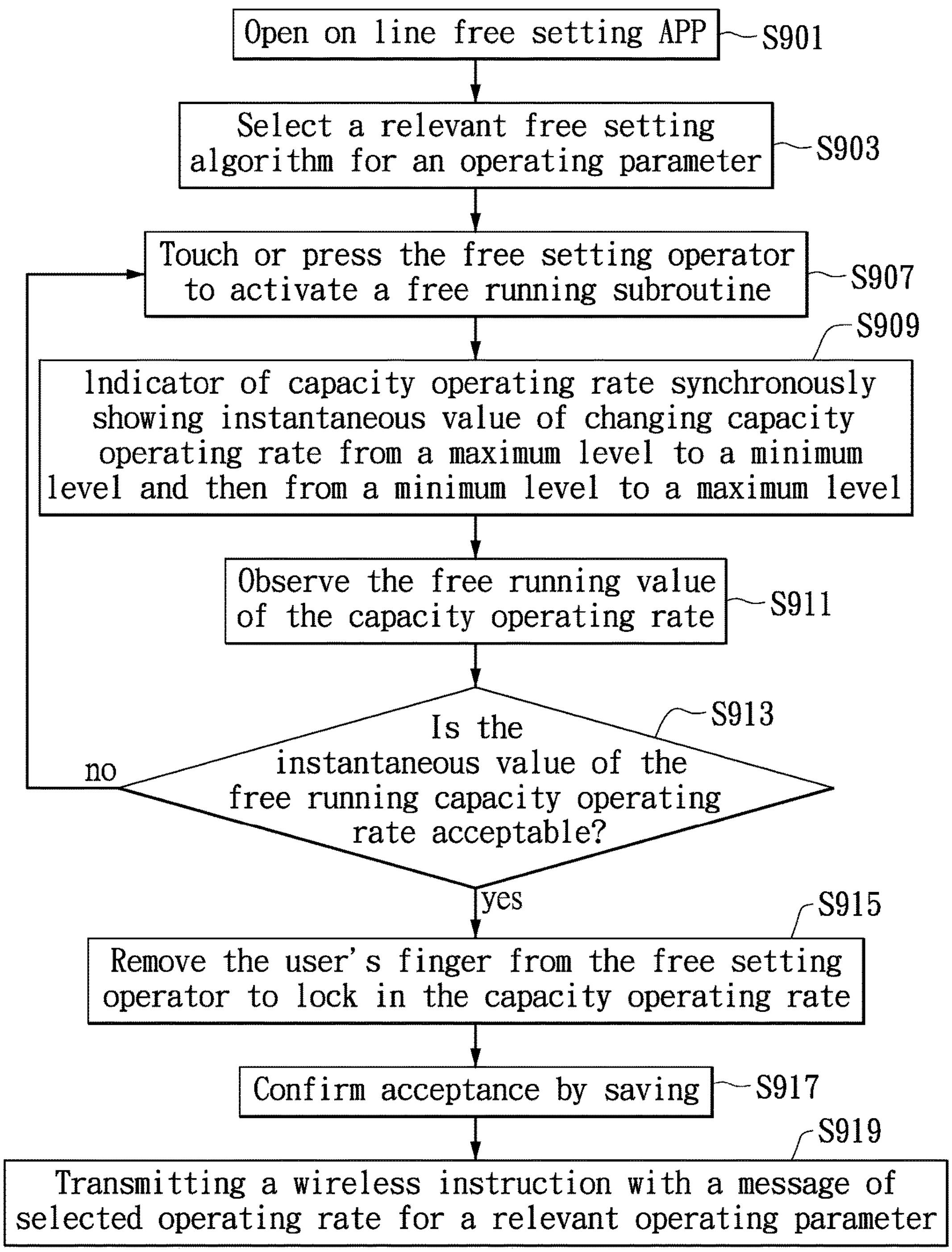

Open on line free setting APP
S901
Select a relevant free setting algorithm for an operating parameter
S903
Touch or press the free setting operator to activate a free running subroutine
S907
S909
Indicator of capacity operating rate synchronously showing instantaneous value of changing capacity operating rate from a maximum level to a minimum level and then from a minimum level to a maximum level
Observe the free running value of the capacity operating rate
S911
S913
Is the instantaneous value of the free running capacity operating rate acceptable?
no
yes
S915
Remove the user's finger from the free setting operator to lock in the capacity operating rate
Confirm acceptance by saving
S917
S919
Transmitting a wireless instruction with a message of selected operating rate for a relevant operating parameter

FIG. 10A

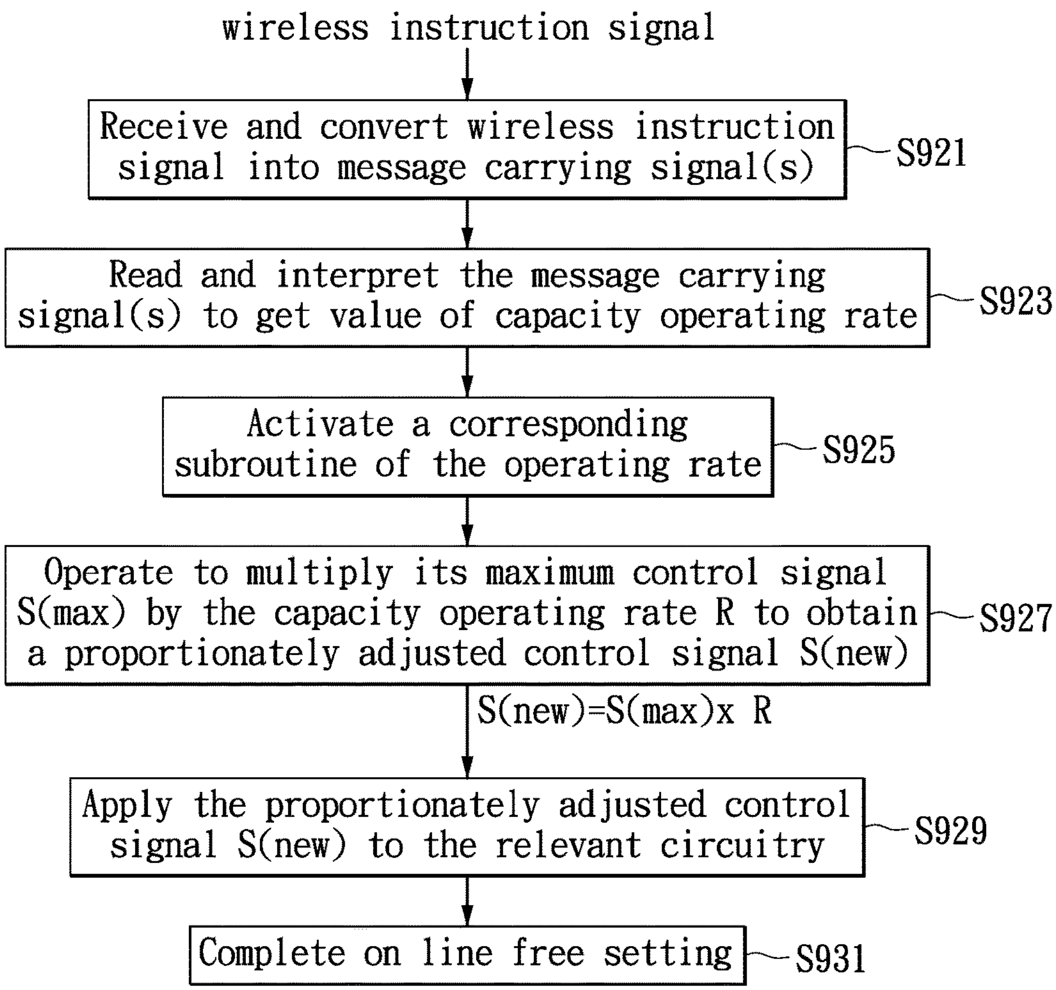

wireless instruction signal
Receive and convert wireless instruction signal into message carrying signal(s)
S921
Read and interpret the message carrying signal(s) to get value of capacity operating rate
S923
Activate a corresponding subroutine of the operating rate
S925
Operate to multiply its maximum control signal S(max) by the capacity operating rate R to obtain a proportionately adjusted control signal S(new)
S927
S(new)=S(max)x R
Apply the proportionately adjusted control signal S(new) to the relevant circuitry
S929
Complete on line free setting
S931

FIG. 10B

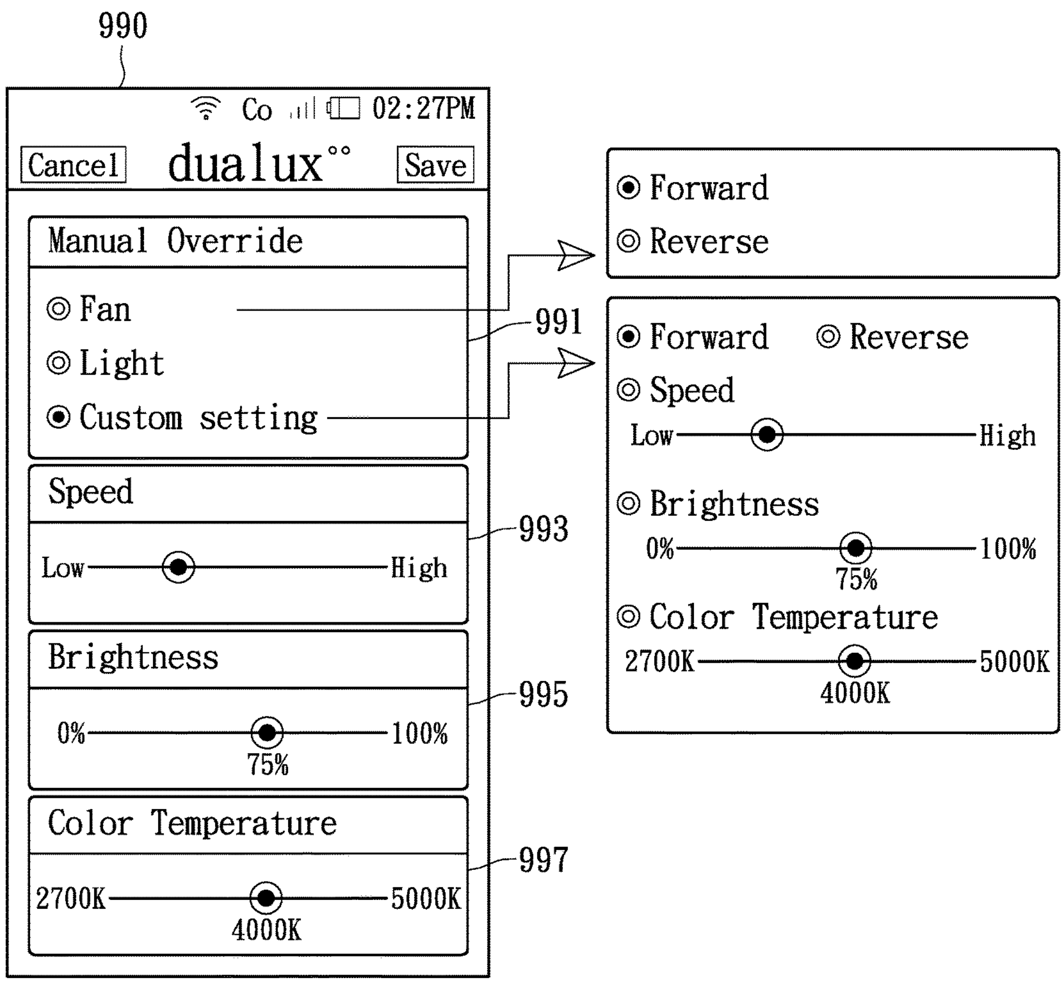

990
Co
02:27PM
Cancel
dualux
Save
Manual Override
Fan
Light
Custom setting
Speed
Low
High
Brightness
0%
100%
75%
Color Temperature
2700K
5000K
4000K
991
993
995
997
Forward
Reverse
Forward
Reverse
Speed
Low
High
Brightness
0%
100%
75%
Color Temperature
2700K
5000K
4000K

FIG. 11

APP BASED FREE SETTING METHOD FOR SETTING OPERATING PARAMETER OF SECURITY LIGHT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part application of application Ser. No. 15/072,602 filed on Mar. 17, 2016, currently pending. This application Ser. No. 15/072,602 is a continuation of Non-Provisional application Ser. No. 14/487,334 filed on Sep. 16, 2014, now U.S. Pat. No. 9,326,362 B2. This U.S. Pat. No. 9,326,362 B2 is a continuation-in-part of Non-Provisional application Ser. No. 13/222,090 filed on Aug. 31, 2011, now U.S. Pat. No. 8,866,392.

BACKGROUND

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a security light with sensors.

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photo sensors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost. With increasing popularity of mobile devices, there exists a good opportunity to elaborate operating functions of the external control unit installed with the motion sensing security light disclosed in U.S. Pat. No. 9,326,362 B2 by utilizing APP based remote control technology. The term APP is generally referred to an application program pre-loaded in a mobile device, such as in a smart cellular phone, for executing customer-designed functions by a user.

SUMMARY

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to a second level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in a first level illumination to save energy, wherein the first level illumination may be a complete light off or a low level ambient light illumination.

An exemplary embodiment of the present disclosure provides a two-level LED security light, comprising a light emitting unit, a loading and power control unit, a photo sensor, a motion sensor, a power supply unit, and an external control unit coupled with the loading and power control unit. The light emitting unit comprises at least one LED, or the light emitting unit is a LED lamp. The loading and power control unit comprises a microcontroller or an application specific integrated circuit (ASIC) electrically coupled with a semiconductor switching device, wherein the semiconductor switching device is electrically connected in series with the power supply unit and the light emitting unit, wherein the microcontroller or ASIC, with program codes outputs a pulse width modulation (PWM) signal to control the conduction period T_{on} and the cut-off period T_{off} of the semiconductor switching device for delivering different average electric currents from the power supply unit to drive the light emitting unit for generating different illuminations, wherein the microcontroller or ASIC controls the semiconductor switching device respectively to have a first T_{on} and a second T_{on} of the conduction period such that the light emitting unit respectively generates a first level and a second level illumination characterized by light intensity and/or color temperature according to the signals received from the photo sensor and the motion sensor, wherein the external control unit is for setting illumination characteristics of at least one of the first level illumination and the second level illumination of the light emitting unit.

Another exemplary embodiment of the present disclosure provides a two-level security light control device applicable to AC lighting sources, comprising a power supply unit, a photo sensor, a motion sensor, a loading and power control unit, a zero-crossing detection circuit, a phase controller, and an external control unit coupled with the loading and power control unit. The phase controller is in-series connected to an AC lighting source and an AC power source, wherein the loading and power control unit comprises a microcontroller with program codes to control a conduction period of the phase controller thereby to adjust the average power of the AC lighting source, wherein when an ambient light detected by the photo sensor is lower than a predetermined value, the AC lighting source is turned on by the loading and power control unit thereby to generate a first level illumination and when the ambient light detected by the photo sensor is higher than the predetermined value, the AC lighting source is turned off by the loading and power control unit; when an intrusion is detected by the motion sensor, the loading and power control unit changes the average power of the AC lighting source and a second level illumination is generated for a predetermined duration, wherein the first level and the second level illumination are characterized by specific light intensity and/or color temperature, wherein the external control unit is for setting illumination characteristics of at least one of the first level illumination and the second level illumination of the light emitting unit.

Another one exemplary embodiment of the present disclosure provides a two-level security light control device applicable to AC lighting sources, comprising a power supply unit, a photo sensor, a motion sensor, a loading and power control unit, a zero-crossing detection circuit, a plurality of phase controllers, and an external control unit coupled with the loading and power control unit. The plurality of phase controllers are respectively series-connected to a plurality of alternating current (AC) lighting

sources, wherein the pairs of phase controller-AC lighting source are parallel-connected to an AC power source, wherein the loading and power control unit comprises a microcontroller for writing operation program to respectively control conduction periods of the phase controllers thereby to respectively adjust the average powers of the AC lighting sources, wherein when an ambient light detected by the photo sensor is lower than a predetermined value, the AC lighting sources are turned on by the loading and power control unit to generate a first level illumination for a predetermined duration and when the ambient light detected by the photo sensor is higher than the predetermined value, the AC lighting sources are turned off, wherein when an intrusion is detected by the motion sensor, the loading and power control unit changes the average power of the AC lighting sources to generate a second level illumination for a predetermined duration, wherein the first level and the second level illumination are characterized by specific light intensity and color temperature, wherein the external control unit is for setting the illumination characteristics of at least one of the first level illumination and the second level illumination of the AC lighting sources.

Another one exemplary embodiment of the present disclosure represents a security light comprising a loading and power control unit connected with a wireless platform wherein system functions of an external control unit and a time setting unit are integrated and implemented by APP based technology to facilitate free setting operating parameters of a security light by a user on a wireless basis, wherein an indicator showing an instantaneous value of capacity operating rate is designed to facilitate the user's selection decision. In fact, the time setting unit disclosed in the U.S. Pat. No. 9,326,362 B2 & etc. as a separate component could have been included in the definition of the external control unit by its nature.

Another one exemplary embodiment of the present disclosure uses an APP based software technology to operate on line free settings of various operating parameters of a security light. The technology enables a user to observe and thereby arbitrarily select any level of an operating parameter in a designated category within its maximum circuitry capacity on an on line computing basis according to his or her observation by operating a free setting algorithm designed and loaded in a mobile device and the security light.

Another exemplary embodiment of the present disclosure is a user interface APP designed and loaded in a mobile device operable on the touch screen panel of the mobile device, wherein the APP operates to transform the user's setting decision(s) into operating variable(s) usable for processing, computing and setting the operating parameter(s) of the security light, wherein the operating variable(s) is wirelessly transmitted via the mobile device to the security light; wherein a software program is loaded in a microcontroller of the security light, comprising at least one subroutine programmed to use the value(s) of the operating variable(s) for computing, adjusting and setting at least one operating parameter of the security light.

Another exemplary embodiment of the present disclosure provides a user interface APP, designed on the touch screen panel of the mobile device, comprising at least one free setting algorithm for setting at least one operating parameter. The free setting algorithm is a capacity scale simulation implemented by a visual configuration of a free setting operator incorporated with a capacitor scale simulator and the indicator of the capacity operating rate to facilitate the user's decision making process in setting a desired level of operating parameter, wherein when the free setting operator is activated by the user to interact with the capacity scale simulator, the user interface APP responsively manages to gradually adjust the value of the capacity operating rate according to the instantaneous state of interaction between the free setting operator and the capacity scale simulator with the indicator of the capacity operating rate simultaneously showing an instantaneous value of the capacity operating rate, wherein the capacity operating rate shown in the indicator can be an operating percentage or an actual operating value of the relevant operating parameter, wherein when a free setting motion of the free setting operator is ceased with at least one setting decision, the user interface APP manages to generate the operating variable(s) corresponding to the selection of the capacity operating rate(s) and accordingly operates to transmit a wireless instruction signal carrying a message of the operating variable to the lighting device.

In the present disclosure two types of capacity scale simulators are illustrated as exemplary embodiments; the first one is a virtual track and the second one is a capacity free running subroutine. When a virtual track is used as the capacity scale simulator, the free setting algorithm is implemented by a visual configuration of the free setting operator coupled with the virtual track and the indicator of the capacity operating rate, wherein the virtual track is designed on the touch screen panel of the mobile device in the relevant free setting algorithm, wherein the free setting operator is slidable by the user's finger along the virtual track with the indicator of the capacity operating rate simultaneously showing an instantaneous value of the changing capacity operating rate while the sliding motion of the free setting operator is being conducted, wherein the value shown in the indicator of the capacity operating rate can be an operating percentage or an actual operating value of the operating parameter, wherein the full length of the virtual track represents a simulation of the value of the maximum operating capacity of a relevant operating parameter characterized by a relevant circuitry, wherein the capacity operating rate is determined by a parking location of the free setting operator on the virtual track when the sliding motion stops. When the capacity scale simulator is a capacity free running subroutine with the free setting operator being a virtual button, the free setting algorithm is implemented by a visual configuration of the virtual button, the capacity free running subroutine integrated with the virtual button and the indicator of the capacity operating rate, wherein the virtual button is designed on the touch screen panel of the mobile device in the relevant free setting algorithm, wherein when the virtual button is continuously touched by a finger of the user, the user interface APP operates to activate the capacity free running subroutine to gradually increase the capacity operating rate from a minimum level to a maximum level and then from the maximum level to the minimum level to complete a full cycle of free running motion, wherein during a free running cycle period the instantaneous value of the changing capacity operating rate is simultaneously shown in the indicator of the capacity operating rate, wherein the value of capacity operating rate can be an operating percentage or an actual operating value of the operating parameter, wherein the moment at which the user's finger is removed from the virtual button, the capacity free running motion is instantly ceased with the capacity operating rate thereby being locked in at the instantaneous level of the last moment of the free running motion, wherein the time length of a half cycle period of the free running motion represents a simulation of the value of the maximum

operating capacity of a relevant operating parameter characterized by a relevant circuitry, wherein the capacity operating rate is determined by the time length the user's finger staying in touch screen panel with the virtual button compared with the time length of a half cycle period of the free running motion.

The free setting algorithm of this embodiment is often used for setting time duration related operating parameters such as the light-on duration triggered by the motion sensor or triggered by the photo sensor, though it can also be used for sensitivity related operating parameters such as detection distance setting for the motion sensor or for the photo sensitivity settings. When the free setting operator determines a capacity operating rate according to the value shown in the capacity operating indicator, a wireless instruction signal carrying the message of the selected capacity operating rate coded with a category of the operating parameter is thereby transmitted by the APP software via a wireless transmission means (Wi-Fi, Blue Tooth, Zig Bee or Radio Frequency) of the mobile device, upon receiving such wireless signal(s) carrying the message of the selected capacity operating rate coded with a category of the operating parameter from the wireless receiver of the security light, the microcontroller with APP software responsively activates a corresponding subroutine to interpret, compute and convert the capacity operating rate into a proportionate time duration value and output a time delay control signal to control the duration of delay time selected by the end user. The confirmation of each selection of capacity operating rate can be done at the time when all relevant capacity operating rates of all categories of operating parameters are completely set and one confirmation by a touch on a confirmation button will simultaneously send all wireless signals carrying various operating rates coded with different operating parameters. Additionally only one value of each operating parameter computed by the microcontroller is retained and stored in a memory of the microcontroller for repetitive performance until a resetting of at least one operating parameter is initiated by the user then the specific category of operating parameter(s) will be replaced with newly computed value(s).

Another one exemplary embodiment of the present disclosure, wherein the operating parameters comprise setting of timer for performing a manual override illumination triggered by the photo sensor, setting of time length of light-on duration triggered by the motion sensor, setting of illumination level triggered by the photo sensor, setting of illumination level triggered by the motion sensor, setting of detection range of the motion sensor, setting of ambient illumination level at which the photo sensor operates to switch on the motion sensor or turn on the sensing security light or alternatively switching the performance state of the security light alternately between a motion sensing security mode and a general illumination mode.

In summary the present disclosures are a continuation of technology enhancement to elaborate operating functions of the external control unit installed with the motion sensing security light disclosed in former applications with a focus on an APP based new remote control technology usable for setting operating parameters of a lighting device. The present invention is applicable to a general lighting device, a single level security light, two level security light or multi-level/life style security light. The lighting load can be a non-linear lighting load such as LED lamp, a linear load such as halogen lamp or any electrically energize-able light emitting material. For single level security light, the motion sensor is switched on at dusk by the photo sensor with the light remaining off, wherein when a motion intrusion is detected by the motion sensor, the light is instantly turned on for a short time duration and in the absence of continued motion intrusion(s) detected the light is then turned off. For the two level security light, the motion sensor is switched on at dusk and at the same time the light is turned on to perform a low level illumination mode, wherein when a motion intrusion is detected by the motion sensor, the light is instantly managed to change from a low level illumination mode to a high level illumination mode for a short time duration before being switched back to the low level illumination mode, the light is automatically switched off at dawn by the photo sensor. For the multi-level/life style security light, the light is automatically turned on at dusk to perform a first level illumination mode for a first predetermined duration and then is switched to a low level illumination mode, wherein when a motion intrusion is detected, the light is instantly managed to perform a high level illumination mode for a second predetermined duration, in the absence of further motion(s) detected, the light is then switched back to the low level illumination mode till at dawn the photo sensor manages to turn off the light and to disconnect the motion sensor.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **2**A illustrates a schematic diagram of a LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**C illustrates in some detail a schematic diagram of a LED security light of FIG. **2**A.

FIG. **2**D illustrates a flow chart of a free running setting method in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a timing waveform of a LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4** illustrates a schematic diagram of a LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **5** illustrates a block diagram of a mobile device for wirelessly controlling the security light of the present disclosure.

FIG. **6**A illustrates a block diagram of the mobile device loaded with an APP software for wirelessly controlling the security light of the present disclosure.

FIG. **6**B illustrates a block diagram of the security light for wirelessly receiving instruction from the mobile device loaded an APP software for free setting of operating parameter(s).

FIG. **7** illustrates a first user interface APP with virtual track configuration designed and loaded in a mobile device for operating free settings of various operating parameters according to the present disclosure.

FIGS. **7**A, **7**B, **7**C, **7**D, **7**E, **7**F and **7**G illustrate virtual track configuration of the free setting algorithm for free setting various operating parameters of the security light, respectively.

FIG. **8**A illustrates a first embodiment of an operating flow chart of the APP based free setting algorithm loaded in a mobile device for operating a free setting operator to slide along the virtual track of a capacity operating scale for selecting and wirelessly transmitting an operating variable.

FIG. **8**B is the first embodiment of an operating flow chart for receiving wireless instruction of operating variable and activating a relevant subroutine of the APP based free setting algorithm loaded in the security light for processing or computing operating variable(s) received from the mobile device.

FIG. **9** schematically illustrates a second user interface APP with virtual button configuration designed and loaded in a mobile device operable on the touch screen panel of the mobile device for operating free settings of various operating parameters using free running subroutines to help a user to set various operating parameters.

FIG. **9**A schematically illustrates the free setting algorithm for selecting a capacity operating rate of motion delay time by continuously pressing a virtual push button and observing the changing value of the indicator.

FIG. **9**B schematically illustrates an exemplary embodiment of the free setting algorithm for selecting a capacity operating rate of high level brightness by continuously pressing a virtual push button, observing the changing value of the indicator and choosing an instantaneous value shown in the indicator.

FIG. **10**A illustrates a second embodiment of an operating flow chart of an APP based free setting algorithm loaded in a mobile device for operating a free running subroutine to select a desired operating variable by the user.

FIG. **10**B illustrates the second embodiment of an operating flow chart for receiving wireless instruction of operating variable and activating a relevant subroutine of the APP based free setting algorithm loaded in the security light for processing or computing operating variable(s) received from the mobile device.

FIG. **11** illustrates another embodiment of the on line free setting algorithms of the present disclosure applied to a ceiling fan with light kit to control fan speed, fan rotation direction, light intensity and light color temperature.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS OF THE SUPPLEMENT

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

Refer to FIG. **1**, which schematically illustrates a block diagram of a security light. A security light (herein as the

lighting apparatus) **100** includes a power supply unit **110**, a photo sensor **120**, a motion sensor **130**, a loading and power control unit **140**, a light emitting unit **150**, a time setting unit **160** and an external control unit **170**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC power converter. The external control unit **170** is coupled with the loading and power control unit **140**, wherein the external control unit **170** can be manipulated by the user for adjusting illumination characteristics of at least one of a first level illumination and a second level illumination of the light emitting unit **150**. The first level and the second level illumination are characterized by light intensity and/or color temperature. For example, the first level illumination and the second level illumination may be a low level illumination (or no illumination) and a high level illumination respectively, but the present disclosure is not so restricted. In other embodiment, the first level illumination may be a first color temperature level illumination, and the second level illumination may be a second color temperature level illumination. The photo sensor **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensor **130** may be a passive infrared ray sensor (PIR), a microwave motion sensor or an ultrasonic motion sensor, which is coupled to the loading and power control unit **140** and is used to detect motion intrusions. When a person is entering a predetermined detection zone of the motion sensor **130**, a sensing signal thereof is responsively transmitted to the loading and power control unit **140**.

The loading and power control unit **140** comprises a controller circuitry which may be implemented by a microcontroller, a microprocessor, an ASIC (application specific integrated circuit) or a programmable integrated circuit coupled to the light emitting unit **150**. The loading and power control unit **140** controls the illumination levels of the light emitting unit **150** in accordance to the sensing signal(s) outputted by the photo sensor **120** and the motion sensor **130**. The light emitting unit **150** includes a plurality of LEDs and switching components. The loading and power control unit **140** may control the light emitting unit **150** to generate different levels of illumination modes. The time setting unit **160** coupled with the loading and power control unit **140** is used to preset various specific time durations respectively for different illumination modes of the light emitting unit **150**. The time setting unit **160** is effectively a type of external control device which could be combined and considered as a component of the external control unit **170**.

For a single level LED security light wherein when an ambient light detected by the photo sensor **120** is lower than a predetermined value, the loading and power control unit **140** manages to switch on the motion sensor **130**, wherein when the ambient light detected by the photo sensor **120** is higher than a predetermined value, the loading and power control unit **140** thereby manages to switch off the motion sensor **130**, wherein when a motion intrusion is detected by the motion sensor **130**, the loading and power control unit **140** responsively manages to turn on the light emitting unit **150** to perform a high level illumination mode for a predetermined short time duration and then operates to turn off the light emitting unit **150** in the absence of any more motion intrusion;

For a two-level LED security light, wherein when the ambient light detected by the photo sensor **120** is lower than a predetermined value the loading and power control unit **140** operates to turn on the light emitting unit **150** to

generate a low level illumination mode, wherein when the ambient light detected by the photo sensor **120** is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light emitting unit **150**, wherein when a human motion is detected by the motion sensor **130**, the loading and power control unit **140** manages to increase the electric current which flows through the light emitting unit **150**, to generate a high level illumination for a short predetermined duration preset by the time setting unit **160**. After the short predetermined duration, the loading and power control unit **140** may automatically reduce the electric current that flows through the light emitting unit **150** thus to have the light emitting unit **150** return to low level illumination for saving energy.

For a multi-level/life style LED security light, wherein when the photo sensor **120** detects that the ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** operates to turn on the light emitting unit **150** to generate a first level illumination mode for a first predetermined duration preset by the time setting unit **160** and is then switched to a second level illumination mode with a lower light intensity, wherein when the photo sensor **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** manages to turn off the light emitting unit **150**, wherein when the motion sensor **130** detects a human motion, the loading and power control unit **140** manages to increase the electric current which flows through the light emitting unit **150**, to generate a high level illumination for a second predetermined duration with relatively shorter time length preset by the time setting unit **160** and after the second predetermined duration, the loading and power control unit **140** automatically reduces the electric current that flows through the light emitting unit **150** thus to let the light emitting unit **150** return to the second level illumination mode for saving energy.

Refer to FIG. **2**A in view of FIG. **1**, FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The photo sensor **120** may be implemented by a photo sensor **220**; the motion sensor **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240** may output a pulse width modulation (PWM) signal, wherein, not depicted explicitly in FIG. **2**A, the PWM signal may be outputted and sent through a buffer component or a conditioner circuitry to the gate of transistor Q**1**; the time setting unit **260** is the time setting unit **160**; and the external control unit **270** is the external control unit **170**. The light emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein an artisan of ordinary skill in the art will appreciate how to replace the transistor Q**1** by other type of the semiconductor switching device. The DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field effect transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a pulse width modulation (PWM) signal to control the average electric current of the LEDs L**1**~L**3**. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto. The external control unit **270** may be an electronic switch being optionally a push button, a touch panel or an infrared ray sensor for inputting voltage signal to adjust illumination characteristics of at least one of the first level illumination and the second level illumination of the light emitting unit. Further, in another embodiment, the external control unit **270** may be a push button, a touch panel, an infrared ray sensor or a wireless remote control device coupled or wirelessly linked to a pin of the microcontroller of the loading and power control unit; wherein, when the push button, the touch panel, the infrared ray sensor or the remote control device is activated, a voltage signal is generated to trigger the microcontroller **240** for performing at least one of the two functional modes, for instance the manual setting and the free-running setting (which would be explained thereafter) of the illumination characteristics. The external control unit **270** may be electrically coupled to the microcontroller **240** (that is the loading and power control unit **140**), such as utilizing electrical connection through conducting wire. In other embodiment, the external control unit **270** may be a remote control device, thus the external control unit **270** is wirelessly linked to the microcontroller **240** by using wireless techniques.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow the user to configure on software base a virtual timer embedded in the microcontroller **240** for executing a subroutine for a predetermined duration to perform the first level or the second level illumination respectively in the PC mode or in the PS mode. Further, if the microcontroller **240** is coupled to a clock device, the time setting unit **260** may allow the user to set a clock time point instead of a predetermined duration for switching from the PC mode to the PS mode. However, the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{on} being longer than the cut-off period T_{off}. On the other hand, in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light emitting unit **250** during the day and activates the PC mode at night by turning on the light emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light emitting unit **250** may switch to the high level illumination for illumination or warning application. The light emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

Please refer to FIG. **2**A to further elucidate illumination level adjustment or setting. In order to adjust the illumination level of the light emitting unit **250**, two exemplary control methods are applied by utilizing the external control

unit **270**. Specifically, the first exemplary method is a manual adjustment applicable when the loading and power control unit **240** executes the Power-Saving (PS) mode for generating a first level illumination. The first level illumination is preferred an illumination of low light intensity and/or low color temperature. Refer to FIG. **2**A again, the microcontroller **240** may scan with its program codes a pin connected with the external control unit **270** and may detect control signal generated from the external control unit **270**. The external control unit **270** may be preferable a push button. When the push button is pressed down by a user to ground the connecting pin of the microcontroller **270**, a zero voltage is generated for a time duration until the push button is released, such that a control signal with a zero voltage of a time duration is generated manually by the user. The microcontroller **240** with program codes recognizes this control signal and by executing a subroutine generates a PWM signal to cause a conduction time period T_{on} periodically varying within a preset range of 0 to 50% duty (T_{on} is equal to T_{off}) for a time length controlled by the external control unit **270**, such that the LEDs **250** generate illumination with light intensity level gradually and periodically increasing from zero to 50% of the maximum light intensity and then decreasing from 50% to zero to complete a repetitive cycle. The time length of such periodical illumination variation is equal to the time duration of zero voltage generated by pushing down the push button **270**. Only when the push button **270** is released by the user, the periodical illumination variation is ended at an illumination level related to a specific T_{on} value determined by the user; then the microcontroller **240** jumps out of the subroutine of periodical illumination variation and stores thereafter the corresponding T_{on} value of the PWM signal in its memory to update a data base for generating a new first level illumination in the PS mode. In brief, by pressing down and releasing the push button **270** connected with a pin of the microcontroller **240**, the illumination level of the light emitting unit **250** can be thus set manually by the user when the loading and power control unit **240** executes the PS mode. However, the present disclosure is not limited thereto.

The second exemplary method is a free-running setting by program codes of microcontroller in conjunction with the external control unit. Refer to FIG. **2**A. When the lighting apparatus is turned on by the photo sensor **220**, the microcontroller **240** starts its program codes by executing a subroutine in which PWM signal is generated with the conduction time period T_{on} periodically varying within a preset range of 0 to 50% duty for a fixed time period, such that the LEDs **250** generate illumination with light intensity level gradually and periodically increasing from zero to 50% of the maximum light intensity and then decreasing from 50% to zero light intensity to complete a variation cycle. This periodical variation of the low illumination level can last freely for two or three cycles within the fixed time period which is preferable to be one minute. However, it is not to limit the present invention in this manner. Within the one-minute fixed time period, for instance, the periodical illumination variation may be ended by activating the external control unit **270**. The external control unit **270** may be preferable a push button. When the push button is pressed down instantly by a user to ground the connecting pin of the microcontroller **270**, a zero voltage is generated to trigger the microcontroller **240** wherein the microcontroller **240** jumps out of the subroutine to terminate the free-running illumination variation and stores the T_{on} value of PWM signal corresponding to the time point when the external control unit **270** being activated. The stored T_{on} value is used

to update a data base for generating the first level illumination in the PS mode. The free-run of periodical illumination variation may automatically end when the one-minute fixed time period expires with the external control unit **270** not being operated by the user; in this case, the microcontroller **240** jumps out of the subroutine of free-run and acquires from its memory a preset or earlier T_{on} value of PWM signal for generating the first level illumination in the PS mode until the lighting apparatus is turned off.

In brief, in a preferred embodiment of the present disclosure, a two-level LED security light may include a power supply unit, a photo sensor, a motion sensor, a loading and power control unit, a light emitting unit, a time setting unit and an external control unit. The external control unit is provided for adjusting or setting illumination level of LED light. The loading and power control unit is implemented by a microcontroller with program codes to operate the two-level LED security light. The microcontroller turns off the light emitting unit during the day and activates a Power-Saving (PS) mode at night by turning on the light emitting unit to generate a first level illumination, and upon human motion detection by switching the light emitting unit to generate a second level illumination for a short time duration. The illumination characteristics of first level illumination can be changed by activating the external control unit according to the user's demand. When the lighting apparatus is turned on, the microcontroller starts its program codes by firstly executing a subroutine with free-run for a fixed time length, such that the user can follow the gradual and periodical illumination variation to select an illumination level by operating the external control unit; thereafter, the microcontroller jumps out of the subroutine of free-run and executes the program codes of PS mode for generating the first level illumination with the selected level characteristics until the lighting apparatus is turned off. If within the fixed time length of free-run the external control unit is not activated, the microcontroller jumps out of the subroutine of free-run automatically and, with a data base of a preset or earlier level characteristics, executes program codes of PS mode for generating the first level illumination until the lighting apparatus is turned off. The level characteristics can also be further adjusted manually by the user when the loading and power control unit executes the PS mode. The external control unit may be preferable a push button. When in PS mode the light emitting unit generates a first level illumination, the user can press the push button for a while to observe the gradual and periodical changing of level characteristic, and then decide at a time point to release the push button to select a desired illumination level, such that to complete manual adjustment.

Please refer to FIG. **2**C in view of FIG. **2**A and FIG. **2**B. Two preferred constructions respectively for the time setting unit **260'** and the external control unit **270'** are shown in FIG. **2**C. The time setting unit **260'** may be a voltage divider with variable resistor for setting predetermined time durations for the first level and the second level illumination. The external control unit **270'** may include a voltage divider **270***a* which may comprise a variable resistor provided with a rotating knob to facilitate operation. For illumination level setting, the microcontroller operates with program codes preferably in conjunction with the voltage divider **270***a* and further with a power supply detection circuit **270***b*, an energy storage capacitor **270***c* and a power switch (not shown in FIG. **2**C) for respectively manual and free-running setting of at least one of a first level illumination and a second level illumination of the two-level LED security light; details of

adjusting illumination level with the external control unit **270'** and other extra devices will be described later.

In order to adjust the illumination level of the light emitting unit **250**, two exemplary control methods are applied by utilizing the external control unit **270***a* and the software technique incorporating with extra devices **270***b*-**270***c*. Specifically, the first exemplary method is a manual adjustment applicable in the Power-Saving (PS) mode for generating a first level illumination. Refer to FIG. **2**C again, the microcontroller **240** may scan with its program codes the voltage on a pin connected with the voltage divider **270***a* and may detect a voltage, in which the voltage across of the variable resistor (voltage divider **270***a*) may be varied manually when a user rotates the knob attached on the variable resistor (voltage divider **270***a*). The microcontroller **240** with program codes generates in response a PWM signal to cause a conduction time period T_{on} proportional to a voltage received from the variable resistor (voltage divider **270***a*). The light emitting unit **250** illuminates accordingly with light intensity level characterized by the conduction time period T_{on} controlled by the voltage of the variable resistor (voltage divider **270***a*). With the external control unit **270'**, the first illumination level of the light emitting unit **250** can be thus set manually by tuning the variable resistor (voltage divider **270***a*) when the loading and power control unit **240** executes the PS mode.

The second exemplary method is a free-running adjustment based on program codes of microcontroller in conjunction with a power supply detection circuit and an energy-stored capacitor. Refer to FIG. **2**C, when the lighting apparatus is turned on, the microcontroller **240** starts its program codes firstly by executing a subroutine of free-run in which PWM signal is generated to cause the conduction time period T_{on} periodically varying within a preset range of 0 to 50% duty for a fixed time period, such that the LEDs **250** generate illumination with light intensity level gradually and periodically increasing from zero to 50% of the maximum light intensity and then decreasing from 50% to zero to complete a variation cycle. This periodical variation of the low illumination level can last freely for two or three cycles within the fixed time period which is preferable to be one minute. However, it is not to limit the present invention in this manner. Within the one-minute fixed time period, for instance, the free-run of periodical illumination variation may be overridden by the user by turning off a power switch momentarily (for 1-2 seconds) and then switching it back on. At the moment when the power switch is turned off and then switched back on, the microcontroller **240** detects this OFF-ON event through a power supply detection circuit **270***b* and leaves the subroutine to terminate free-run, and simultaneously stores the T_{on} value of PWM signal related to the time point of the OFF-ON event to update a data base for generating the first level illumination in the PS mode. In general, the user can follow the gradual and periodical free-run of the low level lighting variation and select a favorable light intensity level by promptly turning the power switch off and again on (short power interruption). After overriding by power interruption, the microcontroller **240** jumps out of the subroutine of free-run and continues its program codes to execute the PS mode in which the illumination level is determined by the user. The free-run of periodical lighting variation may end automatically when the fixed time period expires with power interruption not being detected; the microcontroller **240** jumps out of the subroutine of free-run and acquires from its memory a preset or earlier T_{on} value of PWM signal for generating the first level illumination in the PS mode. Refer to FIG. **2**C again, an energy storage capacitor **270***c* is connected between the high end and the ground of the working voltage V_{DD}. This capacitor **270***c* is for holding the voltage V_{DD} to keep the circuits **240**, **270***b* still working when electric power is interrupted for 1-2 seconds. Therefore, when overriding free-run by short power interruption, an instant zero voltage is detected by the power supply detection circuit **270***b* and recognized by the microcontroller **240** to perform function for selecting and setting a desired illumination level.

In another embodiment, refer to FIG. **1** again, when an ambient light detected by the photo sensor **120** is lower than a predetermined value, the light emitting unit **150** may be turned on thereby by the loading and power control unit **140** to generate an adjustable level illumination for a first predetermined duration and then turned off or switched to a low level illumination, when an intrusion is detected by the motion sensor **130**, the light emitting unit **150** is turned on by the loading and power control unit **140** to generate a high level illumination for a second predetermined duration and then turned off or switched to a low level illumination until the next intrusion detection; when an ambient light detected by the photo sensor **120** is higher than the predetermined value, the light emitting unit **150** is turned off by the loading and power control unit. The time setting unit **160** is used to set the first and the second predetermined duration respectively for the adjustable level illumination and the high level illumination. The external control unit **170** is used in two setting modes for setting illumination characteristics of the adjustable level illumination; wherein the first setting mode is a manual setting, in which the illumination level of the light emitting unit is set in a preset range by activating the external control unit **170**; wherein the second setting mode is a free-running setting, in which the light emitting unit performs a free-run of the adjustable level illumination with light intensity gradually and periodically increasing and then decreasing in a preset range to complete a cycle, wherein the free-run may be terminated by activation of the external control unit **170** at a time point corresponding to a specific light intensity level, such that the light emitting unit performs the adjustable level illumination constantly with the specific light intensity level being set thereof.

In still another embodiment, a lighting management device is provided. Refer to FIG. **1** again, the lighting management device applicable to a lighting load such as the light emitting unit **150**. The lighting management device comprises the loading and power control unit **140**, the power supply unit **110** and the external control unit **170** coupled with the loading and power control unit. The loading and power control unit **140** comprises a microcontroller (such as the microcontroller **240** shown in FIG. **2**A) electrically coupled with a semiconductor switching device (such as the transistor Q1 shown in FIG. **2**A). The external control unit **170** may be a push button, a touch panel, an infrared ray sensor or a remote control device coupled or wirelessly linked to a pin of the microcontroller. The semiconductor switching device is electrically connected in series with the power supply unit and the lighting load, such as the transistor **Q1** is electrically connected in series with the DC source and the LEDs of the light emitting unit **250**, wherein the microcontroller with written program code controls the conduction rate of the semiconductor switching device, wherein the external control unit **170** enables a user to select a desired illumination characteristic during a free running setting process performed by the lighting load, wherein the lighting load operates a free-run of illumination level by gradually and periodically changing the illumination characteristic, wherein the free-run may be terminated by acti-

vation of the external control unit **170** at a time point corresponding to a specific illumination characteristic selected by the user, wherein the microcontroller accordingly interprets the conduction rate of the semiconductor switching device at the time point when the external control unit **170** is activated and the free running is terminated to be the illumination characteristic set for illumination performance, the illumination characteristic is then memorized by the microcontroller for repetitive performance. Further, in one embodiment, the free run setting is terminated and the illumination characteristic of the lighting load is set by turning off a power switch instantly and turning it back on at the time point the lighting load performs a desired lighting characteristic selected by the user.

According to the previous embodiment, a free running setting method with activation of external control unit or through power switch interruption is provided. Refer to FIG. **2**D, the method comprises step **S110**: selecting a desired illumination characteristic during a free running setting process performed by the lighting load by an the external control unit; S**120**: utilizing the lighting load to operate a free-run of illumination level by gradually and periodically changing the illumination characteristic; and **S130**: terminating the free-run by activating of the external control unit or through power switch interruption at a time point corresponding to a specific illumination characteristic selected by the user, wherein the microcontroller accordingly interprets the conduction rate of the semiconductor switching device at the time point when the external control unit is activated or a power switch interruption is detected and the free running is terminated to be the illumination characteristic set for illumination performance, the illumination characteristic is then memorized by the microcontroller for repetitive performance.

In summary, in a preferred embodiment of the present disclosure, a two-level LED security light may employ an external control unit coupled to a loading and power control unit for adjusting or setting the illumination level of the LED light. The external control unit may be a push button, a voltage divider, a touch panel, an infrared ray sensor or other devices for generating control signals having different attributes depending on the category of the external control unit. For instance, a push button generates a binary signal having a zero voltage lasting for a time length equal to the time duration while the push button being pushed down; quite different, a voltage divider generates a DC voltage tuned by rotating a rotary knob attached to the voltage divider. The loading and power control unit may be implemented by a microcontroller with program codes designed respectively accommodating to different control signals of different attributes for generating PWM signal to cause T_{on} value variable according to the control signal attribute, such as to carry out illumination level adjustment or setting. The illumination level characteristics including light intensity and color temperature can be thus set by operating the external control unit.

Refer back to FIG. **1**, wherein the light emitting unit **150** may include a phase controller and one or more parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light emitting unit **150** so as to generate variations in the first level and the second level illuminations. Refer to FIG. **3**A and FIG. **4** in conjunction with FIG. **1**, this embodiment provides a two-level security light

control device applicable to AC lighting sources, comprising the power supply unit **110**, the photo sensor **120** (that is the photo sensor **220**), the motion sensor **130** (that is the motion sensor **230**), the loading and power control unit **140** (that is the microcontroller **240**), a zero-crossing detection circuit **453**, a plurality of phase controllers (one phase controller **452** shown in FIG. **3**A and one phase controllers **551** shown in FIG. **4** are exemplary illustrated), the time setting unit **160** (that is the variable **260'**) and the external control unit **270'** coupled with the loading and power control unit **240**.

Refer to FIG. **3**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The operation of the external control **270'** can be referred to FIG. **2**C and the related description of manual and free-running setting of illumination level, and the earlier description thus the redundant information is not repeated. It is worth mentioning that the power supply detection circuit **270*b*** is implemented by the zero-crossing detection circuit **453**, and the power switch mentioned in the previous embodiment can be implemented by the power switch **160*a*** electrically coupled to the AC power source and the zero-crossing detection circuit **453**. For a two-level LED security light setting up at the ceiling or a high site far from the user, the free-run setting of the illumination level through instant power interruption by utilizing the power switch **160*a*** is very convenient for the user, in which no any added switching device is needed. The main difference between FIG. **3**A and FIG. **2**C is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light emitting unit **450** includes a phase controller **451**, for ease of explanation, but the present disclosure is not so restricted. The phase controller **451** is in-series connected to the AC lighting source (ACLED) and the AC power source, wherein the microcontroller **240** is for writing operation program to control a conduction period of the phase controller **451** thereby to adjust the average power of the AC lighting source (ACLED). In another embodiment, a plurality of phase controller **451** can be also controlled by the microcontroller **240**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light emitting unit **450** when the photo sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the photo sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger the triac **452** to have a small conduction angle for switching the light emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensor) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the zero-crossing detection circuit

453 to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** into conduction at a proper time point thereby to change the average power input to the light emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to

$$t_o < t_D < 1/2f - t_o$$

for a light-source load with a cut-in voltage V_t, wherein $t_o=(\frac{1}{2}\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t(rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (½f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D<6.1 ms.

Refer to FIG. **3**B, which illustrates a timing waveform of the two-level LED security light in accordance to the second exemplary embodiment of the present disclosure. Waveforms (a)-(d) of FIG. **3**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **3**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **3**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **3**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **3**A and FIG. **3**B concurrently for setting ACLED illumination level. In manual setting, the microcontroller **240** with program codes controls the conduction time period t_{on} of the ACLED to be in a preset

$$0 < t_{on} < 1/4f - t_0;$$

range wherein by tuning the variable resistor (voltage divider **270***a*) the light intensity level of the ACLED can be adjusted between zero and 50% of the maximum light intensity. In the free-run setting of illumination level, the microcontroller **240** with program codes controls the conduction time period t_{on} of the ACLED to periodically change in a preset range

$$0 < t_{on} < 1/4f - t_0,$$

such that the ACLED generates illumination gradually and periodically increasing from zero to 50% and then decreasing from 50% to zero of the maximum light intensity. When following the free-run of lighting variation, the illumination level can be set through power interruption momentarily by utilizing the power switch **160***a*.

Refer to FIG. **4**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The operation of the external control **270'** can be referred to FIG. **2**C and the related description of manual and free-running setting of illumination level, and the earlier description thus the redundant information is not repeated. It is worth mentioning that the power supply detection circuit **270***b* is implemented by the zero-crossing detection circuit **554**, and the power switch mentioned in the previous embodiment can be implemented by the power switch **160***a* electrically coupled to the AC power source and the zero-crossing detection circuit **554**. The light emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**, and a phase controller **551**. The phase controller **551** can be treated as two phase controllers **451** (shown in FIG. **3**A) which are parallel-connected. In still another embodiment, a plurality of phase controllers (**451** or **551**) are respectively series-connected to a plurality of alternating current (AC) lighting sources (ACLED), wherein the pairs of phase controller-AC lighting source are parallel-connected to the AC power source. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light emitting unit **550** of FIG. **4** is different from the light emitting unit **450** of FIG. **3**A in that the light emitting unit **550** has more than one ACLEDs and more than one bi-directional switching devices. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **4**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the second level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240**

uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the first level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and the ACLED**2** to conduct for a long period. Thereby, it may render the light emitting unit **450** to generate the second level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the first level or the second level illumination of different hue. The rest of operation theories associated with the light emitting unit **550** are essentially the same as the light emitting unit **450** and further descriptions are therefore omitted.

The present disclosures is a continuation of technology enhancement to elaborate operating functions of the external control unit **170** installed with the motion sensing security light **100** of FIG. **1** with a focus on an APP based new remote control technology usable for setting operating parameters of a motion sensing security light **100**. The present invention is applicable to a general lighting device, a single level security light, a two level security light or a multi-level/life style security light and the lighting load can be a non-linear lighting load such as LED lamp, a linear load such as halogen lamp or any electrically energize-able light emitting material(s); wherein for single level security light the motion sensor **130** is switched on at dusk by the photo sensor **120** with the light emitting unit **150** remaining off, when a motion intrusion is detected by the motion sensor **130** the light emitting unit **150** is instantly turned on for a short time duration and in the absence of continued motion intrusion(s) detected the light emitting unit **150** is then turned off; wherein for the two level security light the motion sensor **130** is switched on at dusk and at the same time the light emitting unit **150** is turned on to perform a low level illumination mode, when a motion intrusion is detected by the motion sensor **130** the light emitting unit **150** is instantly managed to change from a low level illumination mode to a high level illumination mode for a short time duration before being switched back to the low level illumination mode, the light emitting unit **150** is automatically switched off at dawn by the photo sensor **120**; wherein for the multi-level/life style security light the light emitting unit **150** is automatically turned on at dusk to perform a first level illumination mode for a first predetermined duration and then is switched to a low level illumination mode, when a motion intrusion is detected the light emitting unit **150** is instantly managed to perform a high level illumination mode for a second predetermined duration, in the absence of further motion(s) detected, the light emitting unit **150** is then switched back to the low level illumination mode till at dawn the photo sensor **120** manages to turn off the light emitting unit **150** and to disconnect the motion sensor **130**.

In general, a security light **100** (as FIG. **1**, herein as a lighting apparatus) may include a power supply unit **110**, a photo sensor **120**, a motion sensor **130**, a loading and power control unit **140**, a light-emitting unit **150**, a time setting unit **160** and an external control unit **170**. The loading and power control unit **140** may be implemented by a controller circuitry that includes a programmable device, such as a microcontroller, operating with software codes. In practice, the loading and power control unit **140** performs various operating modes of the security light **100** according to sensing signals received from the photo sensor **120** and the motion sensor **130**. The time setting unit **160** and the external control unit **170** are used to adjust or set operating parameters of the loading and power control unit **140** for performing various operating modes. The current state of art provides inconvenient technology, for instance, using many push buttons and rotating knobs, for a user to set or adjust the operating parameters of a security light. It is hence highly recommended to develop user-friendly technology, for instance, wireless remote control technology, to facilitate the settings of a variety operating parameters of the security light **100**.

The conventional wireless remote control technology has been in existence and used for operating electrical apparatuses such as TV sets, air-conditioners, ceiling fans integrated with light kits or lighting items for as many years as we could possibly remember. The advantage of using a wireless remote control technology is the convenience of being able to locally control the various operating functions of the electrical apparatuses which are remotely located in high rise location or distant location "without needing to climb a ladder, lean out a window, reach down from roof, or engage in other inconvenient activities". Such advantage of local controllability is essentially the same for all home appliances with remote control devices though each electrical appliance may have some different operating parameters, the fundamental technologies to operate such different performance functions are of no differences.

One application of wireless technology to remotely modify or set operating parameters of a security light system can be found, for example, in U.S. Pat. No. 7,880,394 B2, which discloses an art of "Lighting Control System to Facilitate Remote Modification of A Fixture Modifiable Operating Parameter". The U.S. Pat. No. 7,880,394 B2 uses an external memory connected to a controller to store a database for each category of operating parameters, such that according to wireless instructions the controller performs simply a process of looking up the table, picking the selected datum from the table and executing the selected operating parameter. The options of each operating parameter are limited to the database pre-installed in the external memory.

In view of prevalent usage of mobile devices, such as smart phone, APP based method can be designed for free setting the operating parameters of a security light system, such that a more flexible, more convenient and more cost effective setting technology, other than what disclosed in U.S. Pat. No. 7,880,394 B2, can be provided.

Referring to FIG. **5** of an exemplary embodiment of the present disclosure, wherein an elaborated security light **500** is provided with a wireless receiver **590** to receive wireless instructions from a mobile device **600** for adjusting and setting various operating functions of the security light **500**. The security light **500** has a similar system structure like the structure described in FIG. **1**, except the time setting unit **160** and the external control unit **170** are now replaced by the wireless receiver **590**, other circuitry components such as the power supply unit **510**, the photo sensor **520**, the motion sensor **530**, the loading and power control unit **540** and the light emitting unit **550** remain unchanged. The wireless receiver **590** is used as a wireless platform for performing various external control functions such that cumbersome work of manual settings on a security light panel can be eliminated. The elaborated security light **500** is featured with a remote setting technology based on the wireless platform of the wireless receiver **590** to work together with an APP software pre-installed in a mobile device **600** to remotely adjust or modify control signal(s) required for performing various operating modes of the security light **500**. The

mobile device **600** is loaded with an APP (application program) for free setting the operating parameters for the security light **500**. The mobile device **600** is implemented by a mobile phone, a pad, a PDA, a notebook or a remote controller. The type of mobile device **600** is not limited thereto. It will be understood that these embodiments are provided by way of example and that other counterpart components may be used as well to effect these teachings.

The present disclosure uses an APP based software technology to operate on line free settings of various operating parameters for a security light **500**. The APP based technology enables a user to arbitrarily select "any level" of a relevant operating parameter. The operating parameter for instance can be a value of motion delay time, a value of sensitivity for photo sensor **520** or motion sensor **530**, a value of brightness or a mode of many time counting related, light intensity setting related, or distance setting related modes. The operating parameter is in a designated category of operating functions within a maximum circuitry capacity.

The present disclosure discloses an on line free setting method to enable an end user to set "any level" of operating parameter in each functional category, the word "any level" fundamentally precludes the possibility of employing conventional remote control technology which uses the pick and play method to alternately modify up to three level (high, medium and low) of operating parameters for operating the security light, such as disclosed in the prior art U.S. Pat. No. 7,880,394; wherein an external memory **104** is designed to store limited predetermined data for various values of operating parameters and a controller **101** simply follows instruction(s) of the wireless instruction played by a user to look up the table stored in the memory and pick the instructed datum/data for execution. Such technology of pick and play is relatively simple and straight forward.

The present disclosure of on line free setting method on the other hand requires a much more sophisticated technology for implementation because the free setting could lead to a large variation of instructions by the user while it is impossible or at least not cost effective for using a big memory to store a large data base for free selection. One better approach to fulfill a free setting capacity is to use an algorithm to compute user's free setting decisions on an on line basis. In other words, the present disclosure is a compute and play method, and the external memory for operating pick and play method as disclosed in the prior art of U.S. Pat. No. 7,880,394 may be no longer needed.

Referring now to FIG. **6**A, the mobile device **600** generally comprises a processor, a memory and a transmitter. An APP based free setting algorithm is loaded into the memory. For example, when the user wants to adjust brightness of the security light **500**, the user uses the mobile device **600** with APP to transmit wireless instruction **609** by the transmitter **607**. The user opens the mobile device APP **601**, which is understood as a user interface APP, and selects one of many functional blocks available. The APP selected function block will accordingly call the relevant APP Subprogram **603** to show a free setting algorithm **605** on the screen of the mobile device **600**. The free setting algorithm **605** comprises a free setting operator, a virtual track coupled with the free setting operator and an indicator of capacity operating rate to provide instantaneous information of the changing capacity operating rate. The free setting algorithm **605** allows the user to select a capacity operating rate by finger sliding the free setting operator along the virtual track with the help of the indicator of capacity operating rate.

When a desired capacity operating rate of a relevant operating parameter of the security light **500** is determined by the user, the user interface APP **601** with free setting algorithm **605** manages to transmit a wireless instruction signal **609** carrying a message coded with selected capacity operating rate as an operating variable for a relevant operating parameter by transmitter **607** to the security light **500**. This transmitter **607** is configured and arranged to selectively transmit the aforementioned instructions for reception by the wireless receiver **590** of the security light **500**.

In simple term, the user interface APP **601** loaded in the mobile device **600** transforms a user's setting decision into an operating variable of the operating parameter, wherein the operating variable is the capacity operating rate. The mobile device **600** wirelessly transmits wireless instruction **609** with an operating variable pertaining to a relevant operating parameter to the security light **500**. The relevant program loaded in the security light **500** is activated to use the value of the operating variable for computing, adjusting and setting at least one operating parameter of the security light **500**. The security light **500** accordingly produces a relevant output based on the selected operating variable(s) of the relevant operating parameter(s).

Please further refer to FIG. **6**B, wherein the security light **500** comprises a wireless receiver **590**, a programmable controller circuitry or a microcontroller **540** loaded with at least one relevant program corresponding to a free setting algorithm of the user interface APP **601** loaded in the mobile device **600**, a light-emitting unit **550**, a photo sensor **520** and a motion sensor **530**, wherein when the security light **500** through the wireless receiver **590** receives a wireless instruction **609**, a relevant program according to the wireless instruction **609** is activated to perform on line free setting of operating parameter.

The free setting algorithm is a capacity scale simulation designed to enable a user to operate setting of capacity operating rate of an operating parameter of a lighting device or an electrical appliance, such as a ceiling fan with light kit or an air conditioner, on a touch screen of a mobile device. It is a method to simulate a maximum capacity of an operating function of a lighting device or an electrical appliance with a scale arrangement which allows a user to select a capacity operating rate of an operating parameter on a simulator. In the present invention two types of capacity scale simulator are disclosed to implement the free setting algorithm; the first capacity scale simulator is a distance length simulator such as a virtual track coupled with a free setting operator, wherein the capacity operating rate is determined by the parking location of the free setting operator on the virtual track, the second capacity scale simulator is a time length simulator such as a virtual button integrated with a capacity free running subroutine, wherein the capacity operating rate is determined by the time length a user continues to touch the virtual button compared with the time length of a half cycle period of the free running cycle period.

Please refer to FIG. **7** which is an exemplary embodiment of the present disclosure in accordance with the aforementioned APP based free setting technology. FIG. **7** illustrates an example of a visualized free setting algorithm of the user interface APP **601**. The free setting algorithm is implemented by visual elements comprising a group of icons on the display screen of a mobile device when a user interface APP of free setting is initiated. Basically, a security light may be designed to operate a variety illumination modes including manual override **701**, motion sensing related settings, such as motion delay time **703** and sensitivity **705**, lighting level adjustment **707** and color temperature setting **709**. The icons shown in FIG. **7** represent free setting

algorithm comprising visual elements like free setting operator **71**, virtual track **75** and digital indicator **73**, to facilitate a user to set operating parameters of a security light. The display image of FIG. **7** is utilized for convenience to explain the free setting of the present disclosure, but not to limit the present invention. Aside from visualization implementation like FIG. **7**, the free setting algorithm may be implemented by acoustic means, for instance, instead of touch visual icons, a type of user interface APP not to be described here may be employed to pick up the user's voice for performing free setting.

Please refer to the function block **701** of FIG. **7** and in view of FIG. **6**A and FIG. **6**B, the present invention discloses the manual override setting method with a manual override free setting algorithm. The manual override setting comprises a test mode, an auto mode, and a custom setting mode. When the test mode is operated, the microcontroller **540** operates to activate a subroutine to disable the photo sensor **520** such that the motion sensor **530** is operable during the day time and the user is able to check the functionality of the motion sensor **530** and make setting decisions for each of operating parameters. When the auto mode is operated, the APP operates to activate a subroutine of preset capacity operating rates for all operating parameters programmed in the APP to wirelessly transmit to the security light **500**, the microcontroller **540** then operates to compute and adjust relevant control signals to cause the security light **500** to perform each operating parameter according to each preset capacity operating rate R. When the custom setting mode is operated, the APP operates to activate a subroutine to temporarily disable the motion sensor **530** for a programmable timer (sub block **701**A) and the user is allowed to slide the free setting operator **71** along the virtual track **75** which serves as a time length counter, the full length of the virtual track **75** is equal to the maximum time length of the programmable timer which could be practically designed at 12 hours. Thus, when a user's finger **5** stops sliding and parks at a location point of ⅓ of the full length of the virtual track **75** for instance, the indicator **73** of the capacity operating rate R simultaneously shows a time period of 4 hours just selected for performing a constant illumination mode counting from the dusk time when the photo sensor **520** automatically turns on the security light **500**. Aside from the fixed time period timer (sub block **701**A) for performing a general illumination, the custom setting mode further provides a clock time timer free setting option (sub block **701**B), wherein the virtual track **75** serves as a clock time scale, wherein when the user's finger **5** is sliding along the virtual track **75**, the indicator **73** of the capacity operating rate R synchronously shows the instantaneous clock time for setting reference and the clock time setting is completed and determined at the parking location when the user's finger **5** stops sliding, to operate custom setting clock time free settings the APP can be programmed to convert or transform a clock time setting into an equivalent of time period setting using the clock time reference from the mobile device **600** and wirelessly transmit such converted time period information to the security light **500** for on line execution. For instance, if the user sets 10 pm as the time point to convert the illumination mode from the timer mode to the motion sensing mode at time of 4 pm, the APP calculates to convert the 10 pm clock time to be an equivalent of 10 (pm)−4 (pm)=6 (hours), the APP accordingly transmits an wireless instruction **609** to operate a time delay of 6 hours counting from the setting moment 4 pm, so configured the microcontroller **540** manages to perform time counting from the setting moment 4 pm for 6 hours to switch the security light **500** from the timer mode to the motion sensing mode regardless when the security light **500** is automatically turned on at a dusk time. The transformation work can also be done by the microcontroller **540** in the security light **500** instead of being done by the APP preloaded in the mobile device **600**, in such case the APP simply provides clock time input to enable an algorithm in the microcontroller **540** to do the conversion job. Further, please refer to FIG. **7**A through FIG. **7**G in accompanying FIG. **7** wherein detailed descriptions of free setting parameters will be made. FIG. **7**A and FIG. **7**B respectively provide schematic illustrations of how free setting is operated with a user interface of the time period free setting algorithm (sub block **701**A) and with a user interface of the clock time free setting algorithm (sub block **701**B). Shown in FIG. **7**A is a time period timer set at 4 hours. Shown in FIG. **7**B is a clock time timer set at 10:30 pm.

The present disclosure further discloses the motion delay time setting method with a motion delay time free setting algorithm. Please refer to a function block **703** of FIG. **7**, when an intrusion motion is detected by the motion sensor **530**, the microcontroller **540** manages to instantly turn on the security light **500** or to increase the illumination of the security light **500** from a low level illumination mode to a high level illumination mode to provide a security alert before operating to resume the turned off state or the low level illumination mode. In this embodiment, the virtual track **75** serves as the motion delay time scale with its full length representing the maximum time length of the motion delay time, wherein when a user's finger **5** slides the free setting operator **71** along the virtual track **75**, an indicator **73** of the capacity operating rate R synchronously shows the instantaneous value of the motion delay time to help the user make a setting decision. If the maximum time length is designed at 20 minutes, a parking location at 5% of the full length of the virtual track **75** is indicated as 1 minute motion delay time by the indicator **73** of the capacity operating rate R, the microcontroller **540** accordingly manages to multiply the maximum motion delay time control signal S(max) by capacity operating rate R, S (new)=S (max)×R=20 minutes×5%=1 minute and accordingly operates to perform a motion delay time of 1 minute. FIG. **7**C corresponding to functional block **703** is a schematic illustration of how free setting is operated with a user interface of the motion delay time free setting algorithm. Shown in FIG. **7**C is a motion delay time set at 1 minute or 5% of the maximum motion delay time.

The present disclosure further discloses the detection sensitivity setting method with a detection distance free setting algorithm. Please refer to a function block **705** of FIG. **7**, which schematically illustrates the user interface for free setting the operating parameter of detection distance for the motion sensor **530**. The full length of the virtual track **75** represents the maximum detection distance, wherein when a user's finger **5** slides the free setting operator **71** along the virtual track **75**, an indicator **73** of the capacity operating rate is provided to synchronously show the instant changing value of the detection distance to help the user make a setting decision for a detection distance, if the maximum detection distance for the motion sensing circuitry is designed at 70 feet, when the user stops sliding and parks the free setting indicator **73** at a point equal to 30% of the full length of the virtual track **75**, the indicator **73** of the capacity operating rate synchronously shows a detection distance of 70 feet×30%=21 feet is set for performing the detection distance of the motion sensor **530**, the APP thereby transmits a wireless instruction **609** of the capacity operating rate valued at 30% to the security light **500**, the microcontroller

540 upon receiving the wireless instruction **609** operates to activate a corresponding subroutine to proportionately adjust the voltage signal controlling the amplification of motion sensing signal and therefore the detection distance of the security light **500** is set for 21 ft. FIG. **7**D corresponding to the functional block **705** provides a schematic illustration of how free setting is operated with a user interface of the sensitivity distance free setting algorithm. Shown in FIG. **7**D is a detection distance set at 21 feet or ⅓ of the maximum detection capacity.

The present disclosure further discloses the brightness setting method with an illumination level free setting algorithm. As shown in a function block **707** of FIG. **7** wherein the brightness free setting algorithm comprises a subroutine **707**A for setting high level illumination mode and another subroutine **707**B for setting low level illumination mode. In the functional sub block **707**A for setting the high level illumination mode, the length of the virtual track **75** represents the adjustable range of brightness level from a minimum starting point of 50% to a maximum ending point of 100% of designed maximum illumination capacity or from the minimum operating value of 1000 lumens to the maximum operating value of 2000 lumens. When a user slides the free setting operator **71** along the virtual track **75** of the capacity operating scale from the minimum starting point to the maximum ending point, the indicator **73** of the capacity operating rate synchronously changes its value from 50% to 100% or from 1000 lumens to 2000 lumens to help the user to make a parking decision based on the instantaneous percentage value or the actual operating value shown in the indicator **73** of the capacity operating rate. In the functional sub block **707**B for setting the low level illumination mode, the length of virtual track **75** represents an adjustable range of brightness level from a minimum starting point of 0% to a maximum ending point of 50% of designed maximum capacity. When the user slides the free setting operator **71** along the virtual track **75** from the minimum starting point to the maximum ending point, the indicator **73** of capacitor operating rate synchronously changes the percentage value from 0% to 50% or from 0 lumens to 1000 lumens to help the user to make a parking decision based on the instantaneous operating percentage or actual operating value shown in the indicator **73** of the capacity operating rate. FIG. **7**E and FIG. **7**F respectively corresponding to sub block **707**A and sub block **707**B provide schematic illustrations of how free setting is operated with a user interface of the brightness free setting algorithm for the high level illumination mode and for the low level illumination mode. Shown in FIG. **7**E is a brightness level set at 75% of the maximum illumination level or 1500 lumens lighting output for the high level illumination mode. Shown in FIG. **7**F is a brightness level set at 20% of the maximum illumination capacity or 400 lumens lighting output for the low level illumination mode. FIG. **7**G corresponding to the functional block **709** provides a schematic illustration of how free setting is operated with a user interface of the color temperature free setting algorithm. Shown in FIG. **7**G is a color temperature set at 3000 K.

So configured with the user interface free setting algorithm, when the user is sliding the free setting operator **71** along the virtual track **75**, the instantaneous capacity operating rate will be simultaneously shown in the indicator **73** of the capacity operating rate and thereby the user can instantly make a setting decision according to information provided by the indicator **73** of the capacity operating rate, the numerical information shown in the indicator **73** of the capacity operating rate can either be a percentage of the maximum capacity or an absolute number of operating parameter, for instances, if the operating parameter is for detection distance it is more meaningful to show the detection distance being 21 feet or 35 feet instead of 30% or 50%. Also good are operating parameters having to do with time length such as the motion sensor **530** activated light-on duration or a manual override mode wherein the motion sensor **530** is temporarily disabled for a longer time duration, for these types of operating parameters the user will appreciate more for knowing an absolute number rather than a percentage value. Regardless it can be designed with a program code to alternately change between an operating percentage and an absolute number, the user can simply click or double click the free setting operator **71** to make such switch.

So configured with the interface free setting algorithm, the user is allowed to slide the free setting operator **71** between a minimum starting point and a maximum ending point on the virtual track **75** to decide a parking location for the free setting operator **71** and consequently a capacity operating rate is determined according to the indicator **73** of the capacity operating rate; when a confirmation/save button is pressed, the APP software accordingly manages to send out thru the mobile device **600** a wireless instruction signal **609** carrying a message of the capacity operating rate coded with a pertaining category of operating parameter, via a wireless transmission means (as Wi-Fi, Blue Tooth or RF) of the mobile device **600** to the security light fixture **500**. For practical consideration, it could be designed to have the capacity operating rate starting from a minimum value instead of from zero point. For example, the motion delay time needs to have some minimum value such as 5 seconds. Otherwise, the motion sensor **530** would not perform at zero setting which may confuse the user. Same consideration on the detection distance setting that it has to start from some minimum value, such as two feet. Otherwise, the motion sensor **530** would never perform its function at zero setting. This just means that the starting length section from zero to the minimum value is blocked and hidden, it does not change the algorithm of calculating capacity operating rate by using the length P of a parking location measured from the starting zero point divided by the full length of the virtual track **75** "L", namely,

$$R=P/L$$

In addition, the contact between the user's finger **5** and the APP touch screen can not be a single point because the finger **5** has its minimum contacting area, it is practically meaningful to configure the length of the virtual track **75** in multiples of a minimum percentage increment. For example, if the minimum percentage increment is set at 5%, it means a total of 20 partition intervals are divided with the abscissa of each partition interval standing for a capacity operating rate of a multiple of 5%. Hence, the track length of the virtual track **75** is progressively built up from 0%, 5%, 10%, . . . , 95%, to 100%. Therefore, when the user's finger **5** slides along the virtual track **75**, the capacity operating rate shown in the indicator **73** of capacity operating rate synchronously varies according to a sequence pattern of 0, 5%, . . . , 95%, and 100%. Therefore, when the user parks the free setting operator **71** at a point of the virtual track **75**, said parking location falls in a partition interval with a corresponding capacity operating rate equal to some multiple of 5% increment.

The user interface **700** of the APP comprises at least one slidable free setting operator **71** coupled with at least one virtual track **75** and at least an indicator **73** of the capacity

operating rate nearby the free setting operator **71** for instantaneous reference. The free setting operator **71** is slidable by the user's finger **5** along the virtual track **75**, the virtual track **75** represents a simulation of the circuitry operating capacity of the security light **500** with respect to a category of operating parameter. For instance, if detection distance is referred as the operating parameter, the full length "L" of the virtual track **75** represents the maximum detection distance designed with the circuitry of the security light **500** for operating the detection distance, so configured, the detection distance can be adjusted by sliding the free setting operator **71** along the virtual track **75** from a starting point of minimum value to an ending point of maximum capacity. When the user stops sliding and parks the free setting operator **71**, for instance, at a middle point on the virtual track **75**. The capacity operating rate indicated is 50% or 35 feet if the maximum detection distance is 70 feet. The capacity operating rate is shown in the indicator **73** of the capacity operating rate designed on a screen location nearby the free setting operator **71** to provide the user with an instantaneous update the value of capacity operating rate while sliding motion is being conducted. The value shown on the indicator **73** of the capacity operating rate can be a relative percentage information or an absolute value information depending on the characteristic of the designated operating parameter(s). The objective of the present disclosure is to help the user to make easy free setting decisions based on the indicated information. The illustrations shown in FIG. **7**C and FIG. **7** D are an exemplary embodiment of the present disclosure to provide visual indications of absolute values respectively for motion delay time setting and detection distance setting, such that the user can certainly appreciate the time length information and detection distance information which can help them to make sliding and parking decision.

Corresponding to the free setting algorithm of the mobile device **600** part, the security light **500** part has a relevant software program which is the APP software loaded in the microcontroller **540** of the security light **500** for on line computing designated operating parameter(s) using the input of capacity operating rate R received from the user interface APP of the mobile device **600**. A plurality of sub-routines are designed to process corresponding operating parameters. Thus when a wireless instruction **609** generated by the user interface APP by the user is received through the wireless receiver **590**, the microcontroller **540** operates to activate a corresponding subroutine to interpret, compute and proportionately adjust the level of a relevant voltage control signal or time length control signal controlling the respective operating parameters of the security light **500** to perform the selected level(s) of the operating parameter(s). The capacity operating rate R is readable and interpretable to the microcontroller **540** for each category of operating parameters. Each subroutine pertaining to a category of operating parameter operates to multiply its maximum capacity value of control signal S(max) which can be a voltage control signal or a time length control signal by the capacity operating rate R to obtain a proportionately adjusted signal strength S (new)=S(max)×(R), the new control signal S(new) thereby operates to change the operating parameter accordingly. For example, if the free setting operator **71** is parked at 60% point on the virtual track **75** for the detection distance category of an operating parameter, the microcontroller **540** accordingly understands the user has set 42 feet (75 feet×60%) to be the detection distance and therefore responsively manage to proportionately adjust a voltage signal controlling the motion sensing circuitry.

Please refer to FIG. **8**A which schematically illustrates a flow chart for the mobile device part to perform the free setting algorithm of the present disclosure. In step S**801**, the user requires to open up the user interface APP with on line free setting method designed in a mobile device **600**, such as to start the operation of the free setting algorithm. Then, in step S**803**, the user selects a relevant free setting algorithm designed for setting a specific operating parameter, for instance, selecting one operating parameter of Manual mode, Motion Delay Time, Sensitivity and Brightness. In step S**805**, the user slides the free setting operator **71** along the virtual track **75** to adjust the operating variable of selected operating parameter. In step S**807**, the APP operates to compute and convert the user's instantaneous sliding position into the capacity operating rate R, wherein the operating variable is the capacity operating rate R.

In step S**809**, the user observes the changing instantaneous value of the capacity operating rate R shown in the indicator **73** of the capacity operating rate R. In step S**811**, the user decides an acceptable capacity operating rate R by parking the free setting operator **71** at the decision moment. In step S**813**, the user confirms acceptance of the capacity operating rate R by pressing the saving button. Then in step S**815**, the APP operates to wirelessly transmit wireless instruction **609** with the selected capacity operating rate R to the security light **500**. Further refer to FIG. **8**B which schematically illustrates the flow chart for the security light **500** part to perform the free setting algorithm of the present disclosure. In step S**821**, the wireless instruction **609** generated by the user interface APP pre-loaded in the mobile device **600** is received and converted by the wireless receiver **590** of the security light **500** into a message carrying signal(s). Then, in step S**823**, the microcontroller **540** of the security light **500** reads and interprets the message carrying signal to derive the percentage value of the capacity operating rate R. In step S**825**, the microcontroller **540** operates to activate a corresponding subroutine of the designated operating parameter. In step S**827**, the subroutine operates to perform computation of multiplying the stored maximum value of control signal S(max) by the received percentage value R of the capacity operating rate R to obtain a new control signal S(new), namely, S (new)=S(max)×R. In step S**829**, the microcontroller **540** operates to apply such proportionately adjusted control signal S(new) to operate the relevant performing circuitry, the on line free setting of the operating parameter is thereby completed as step S**831**.

The user interface APP for free setting operates to transform the user's setting decision into capacity operating rate for wireless transmission to a remotely located security light **500**. There may be many methods to configure free setting algorithm of the mobile device. The first method disclosed is a virtual track method as shown in FIG. **7** wherein the user interface APP with free setting algorithm comprises a free setting operator **71**, a virtual track **75** coupled with the free setting operator and an indicator **73** of capacity operating rate, wherein the free setting operator **71** is slidable by the user's finger **5** along the virtual track **75** with the indicator **73** of capacity operating rate simultaneously showing an instantaneous value of the capacity operating rate while the sliding motion of the free setting operator is being conducted, wherein the value shown in the indicator **73** can be an operating percentage of the maximum operating capacity of the operating parameter or an actual operating level of the operating parameter, wherein the full length of the virtual track **75** represents a simulation of the maximum operating capacity of the relevant operating parameter characterized by a relevant circuitry, wherein the virtual track **75** is divided

into a number of small compartments representing different values of capacity operating rates being lined up according to value sequence to form the full length of the virtual track, wherein capacity operating rate is determined by the parking location of the free setting operator falling in a compartment of the virtual track with a corresponding capacity operating rate when the sliding motion stops, wherein when a parking decision is made, the user may touch or press the "Save" button on the upper right corner of the APP screen and the APP accordingly manages to transmit via the mobile device a wireless instruction signal carrying a message of the selected capacity operating rate to the security light.

Aside from the above described virtual track method as a first capacity scale simulator, the present invention also discloses a second capacity scale simulator using a virtual button method. Please refer to FIG. **9** which is a preferred exemplary embodiment of the present disclosure. FIG. **9** is an image of the user interface APP **770** using virtual button method that may be displayed on the screen of a mobile device. The user interface APP **770** may comprise a plurality of free setting algorithms loaded in the mobile device **600** for setting various operating parameters including at least settings of manual override mode **771**, setting of motion delay time mode **773**, setting of sensitivity **775**, setting of high level brightness **777**A and setting of low level brightness **777**B. Each free setting algorithm for a relevant operating parameter comprises a free setting operator **72**, a free running subroutine (not shown) and an indicator **74** of the instantaneous capacity operating rate, wherein the free setting operator **72** is a virtual button designed on the touch screen panel of the mobile device **600**. When the virtual button is continuously touched by a finger **5** of the user, the user interface APP operates to activate a free running subroutine to gradually increase the capacity operating rate from a minimum level to a maximum level and then from the maximum level to the minimum level to complete a full cycle of free running motion with a pace which allows the user to observe, determine and take action. During a free running cycle period, the instantaneous value of the changing capacity operating rate is simultaneously shown in the indicator **74** of the capacity operating rate, wherein the value of capacity operating rate can be an operating percentage or an absolute operating value of the operating parameter, wherein the moment at which the user's finger **5** is removed from the virtual button **72**, the free running motion is instantly ceased with the capacity operating rate thereby being locked in at the instant level of the last moment of the free running motion. The time length of a half cycle period of the free running motion represents a simulation of the value of the maximum operating capacity of a relevant operating parameter characterized by a relevant circuitry, wherein the time length of each half cycle is divided into a number of time compartments representing different values of capacity operating rates being lined up according to value sequence, wherein the capacity operating rate is determined by the time point when the user's finger is removed from the virtual button, wherein the time point corresponds to a time compartment configured with a capacity operating rate. When a setting decision is made, the user interface APP manages to transmit via the mobile device wireless instruction signals to the security light to set the operating parameter.

Please refer to FIG. **9**A and FIG. **9**B in view of FIG. **9**, which schematically illustrate images of the user interface APP **770** respectively to highlight motion delay time setting **773** and high level brightness setting **777**. When the virtual button **72** is continuously touched by a finger **5** of the user, the user interface APP operates to activate a free running subroutine to change cyclically the capacity operating rate from a maximum value to a minimum value, and vice versa, with a pace which allows the user to observe, determine and take action. During a free running cycle period, the instantaneous value of the changing capacity operating rate is simultaneously shown in the indicator **74** of the capacity operating rate, for instance, "5 s" of motion delay time in FIG. **9**A and "75%" of high level brightness in FIG. **9**B. If the user releases his finger from the virtual button **72** at a time point to select a value, the indicator **74** locks at a value of capacity operating rate that is what the user wishes. When a setting is done, the user may touch or press the "Save" button to transmit via the mobile device wireless instruction signals to the security light to set the relevant operating parameter. Basically, based on the advantage of the free running subroutine, the virtual button method represented by FIG. **9** uses less icons in implementing the free setting algorithm than the virtual track method represented by FIG. **7**

FIG. **10**A and FIG. **10**B as shown are operating flow charts of the on line free setting APP similar to FIG. **8**A and FIG. **8**B, the only difference between FIG. **8**A and FIG. **10**A is the implementation method for free setting the capacity operating rate. FIG. **8**A illustrates the virtual track method by sliding a free setting operator **71** along a virtual track **75** of a capacity operating scale and with the help of indicator **73** providing the instantaneous value of capacity operating rate while sliding motion is being conducted, the user is able to instantly choose a parking point to determine a desired capacity operating rate. FIG. **10**A illustrates the virtual button method by continuously touching a virtual button **72** of a free setting operator to activate a free running subroutine and with the help of indicator **74** providing instantaneous value of changing capacity operating rate the user is able to instantly choose a time point to de-touch the virtual button **72** to lock in a free running capacity operating rate. In other words, the free setting method of FIG. **8**A uses a distance length simulation approach to derive the capacity operating rate while the free setting method of FIG. **10**A uses a time length simulation approach to derive the capacity operating rate. The instantaneous value of capacity operating rate can either be an operating percentage or an actual operating value; it can be designed such that a simple touch or double touches within a short time interval on the free setting operator can alternatively switch between showing an operating percentage and showing an absolute value of the capacity operating rate. So configured in step **901** the user is required to open On Line Free Setting APP on the touch screen panel of a mobile phone. In Step **903** the user selects a relevant free setting algorithm for an operating parameter. In Step **907** the user touches or presses the free setting operator to activate a free running subroutine. In Step **909**, the free running subroutine enables the indicator of capacity operating rate synchronously showing instantaneous value of gradually changing capacity operating rate from a minimum level to a maximum level and then from the maximum level to the minimum level to complete an operating cycle. In Step **911**, the user observes the changing free running value of the capacity operating rate. In Step **913**, the user decides to select an instantaneous value of the free running capacity operating rate. In Step **915** the user removes his finger from the free setting operator to lock in the instantaneous value of capacity operating rate. In Step **917** the user confirms acceptance of the locked in value of capacity operating rate by pressing the Save button. In Step **919**, the APP operates to transmit a wireless instruction with

a message of selected operating rate coded with the relevant operating parameter to the security light **500**. FIG. **10**A as a user interface APP is the first part of the on line free setting APP loaded in a mobile phone operable on the touch screen panel of the mobile phone. FIG. **10**B is the second part of the on line free setting APP loaded in the microcontroller of the security light **500** to interpret, compute and set operating parameter(s) according to the wireless instruction(s) received from the mobile phone.

As shown in FIG. **10**B, the second part of on line free setting APP starts with Step **921** wherein the receiver of the security light receives and convert wireless instruction signal into message carrying signal(s). In Step **923** the microcontroller reads and interprets the message carrying signal(s) to obtain value(s) of capacity operating rate(s). In Step **925** the microcontroller accordingly activates a corresponding subroutine for processing the operating rate. In Step **927**, the APP operates to multiply its maximum control signal S(max) by the capacity operating rate R to obtain a proportionately adjusted control signal S(new). In Step **929**, the microcontroller manages to apply the proportionately adjusted control signal S(new) to the relevant circuitry. In Step **931** the on line setting of a relevant operating parameter is completed.

In summary, the present disclosure of APP based on line free setting method for determining operating parameters of a security light **500** offers users excellent values of convenience, functionality as well as cost savings when compared with the traditional remote control technology in view of the following feature comparisons.

The present disclosure employs a compute and play technology for free setting operating parameters while the traditional remote control uses pick and play method for modifying operating parameter. The pick and play method requires an external memory to store all predetermined values of operating parameters for pick and play by a controller according to the wireless instruction **609**. It can only offer a limited selection constrained by the memory capacity and adds cost of installing such memory unit. The present disclosure on the other hand is capable of offering an on line free setting of operating parameter through a computing algorithm. No external memory is used to pre-store a limited database for pick and play performance.

The free setting algorithm is an APP software designed for improving the inconvenience of traditional hardware based remote control technology. Prior art such as U.S. Pat. No. 7,880,394 (the 394 prior art) is a rather old technology compared with the present invention; the 394 prior art was an obvious combination of two existing technologies available at time of patent filing. The two existing technologies including pick and play method and remote control method had been used for a long time in TV program selection, air conditioner control, ceiling fan and light kit control . . . etc. before the filing day of the 394 prior art. The user interface disclosed in the 394 prior art is a relatively old technology, wherein the remote controller comprises a multiple of hardware based push buttons for alternatively setting up to three levels (high, medium and low) of various operating parameters. It simply serves as a medium for transmitting a user's selection decision to the control circuitry of the security light to perform pick and play function to alternatively modify operating pentameters. The user interface of the present invention on the other hand offers more features which are superior to the 394 prior art;

The user interface of the present invention can be free loaded in a mobile phone. This represents a great convenience and cost saving. No extra money is required to spend

for furnishing a separate remote controller. The mobile phone has a massive capacity in terms of storage memory and computing power. The external memory used in the 394 prior art is negligible when compared with the massive memory capacity of giga bytes installed in a smart mobile phone which is designed for taking thousands of photographs. A slight allocation of memory capacity of a mobile phone would be more than multiples of the said external memory used in the 394 prior art and there is no extra cost for making use of the mobile phone capacity for controlling the lighting characteristics of the security lights. Additionally, the smart phone is in fact a computer with massive computing and processing power which can be further used to make a connected lighting device become highly intelligent with the help of artificial intelligence and machine learning technologies.

The algorithm of the user interface is designed with user friendly features; unlike the 394 prior art which can only operates high/medium/low options by consecutively pressing a button for a relevant operating parameter, the present invention actually can offer a lot more options of operating parameters with the memory capacity of mobile phone. Furthermore, the indicator is able to provide instantaneous status of changing capacity rate while free setting is in process therefore the user is well aware of what he can choose and thereby making a desired setting decision.

There is no extra operating cost as it becomes an application of the mobile phone. Hassles such as unable to locate the whereabouts of remote controllers and battery run out because of non-frequent use would no longer be a concern as the mobile phone is always in your purse or pocket for any time use and the battery is frequently charged.

The user interface APP pre-loaded in the mobile device enables the lighting fixture to have an access to the use of the massive capacity of storage memory and computing power of the mobile phone. Comparatively the 394 prior art teaching the method of installing an external memory in the lighting fixture for performing pick and play becomes an outdated technique. For using the massive capacity of storage memory and computing power of a smart phone, the job of computing various operating parameters can be done in either the APP of the mobile phone or the program codes written in the microcontroller of the lighting fixture. For computing job done in the mobile phone the operating variables generated are operating parameters while for computing job done in the microcontroller of the lighting fixture the operating variables generated are capacity operating rates. In either case no external memory is required.

The capacity scale simulation disclosed in the present invention is a user friendly technology enabling the user to free set a desired level of operating parameters with the help of capacity operating rate indicator. The 394 prior art simply does not have any user friendly skills comparable to the present disclosure.

In the present disclosure more useful operating functions are designed to fully capitalize the benefit of on line setting method; a good example is the manual override mode, instead of switching to a straight dusk to dawn lighting mode. The present disclosure instead offers an adjustable timer mode, wherein the user is able to set any time duration for operating a general illumination mode with motion sensor **530** being disabled, the user simply slides the free setting operator **71** along the capacity simulation scale of the virtual track **75** to decide the time length wanted for night activity. Additionally, such general illumination mode can be set with clock time point instead of time length, such arrangement is only possible with the mobile device **600** to

provide clock time input. Another good example is the illumination level adjustment for various illumination modes activated by either the photo sensor **520** or the motion sensor **530** as different users may have different preferences according to their life styles. The on line free setting method of the present disclosure enables the user's to select any level of lighting brightness by sliding the free setting operator **71** respectively along the capacity simulation scale of the virtual track **75** for the high level illumination mode from 50% to 100% of full brightness and low level illumination mode from 0% to 50%, when the low level is set at 0% the security light **500** is a single level security light, otherwise it is a two level security light or a multilevel/life style security light.

Please refer to FIG. **11** of a preferable exemplary embodiment of the present disclosure. The APP based technology can be further extended to include additional functionality wherein the security light **500** may be integrated with other electric appliances, for instance, with an electric ceiling fan. Probably, a combinatorial system of a security light **500** with a ceiling fan is accomplished by modifying the controller circuitry of the loading and power control unit **540**. FIG. **11** illustrates a visualized implementation example of free setting algorithms of a user interface APP for a combinatorial system consisting of security light and ceiling fan wherein visual selection elements representing Fan, Light and Custom setting are designed under the category of Manual Override **991** to offer a user the advantage to select appropriate elements and to on line set operating parameters of both the security light **500** and the ceiling fan. Accordingly, for example, the ceiling fan is controlled to rotate in forward or reverse direction with fan speed adjustable by operating the user interface APP. In simple term, the operating parameter of the present disclosure is used for controlling at least one of various lighting and electrical characteristics of the ceiling fan with light kit including timer settings, fan speed settings and fan rotation direction settings, light intensity settings and light color temperature settings.

The above-mentioned descriptions for various embodiments of free setting algorithm represent merely the exemplary embodiments of the present disclosure without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alterations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. An on line free setting method for setting an operating parameter of a lighting device, comprising:

a user interface APP comprising at least one free setting algorithm preloaded in a mobile device to transform a user's setting decision into at least one operating variable of an operating parameter of the lighting device, wherein the user interface APP is operable on a touch screen panel of the mobile device;

wherein when the user interface APP is activated and concluded with at least one setting decision, the user interface APP manages to transmit via the mobile device at least one wireless instruction signal carrying a message of the operating variable to the lighting device, wherein the operating variable is used for processing a value of the operating parameter of the lighting device; and

a microcontroller of the lighting device, designed with a capacity to interpret the wireless instruction signal received by a wireless signal receiver of the lighting device and accordingly manages to output at least one control signal to control and set the value of at least one operating parameter of the lighting device;

wherein the value of the operating parameter is stored in a memory of the microcontroller for repetitive performance, wherein the stored value of the operating parameter is replaceable by a processing of new operating variable selected by the user;

wherein the operating parameter is used for controlling at least one of various lighting characteristics of the lighting device including timer settings, light intensity settings, color temperature settings or detection sensitivity settings when a photo sensor or a motion sensor is involved;

wherein the free setting algorithm is a capacity scale simulation process implemented by a visual configuration of a free setting operator incorporated with a capacity scale simulator and an indicator of the capacity operating rate to facilitate the user's decision making process in setting a desired level of the operating parameter, wherein when the free setting operator is activated by the user to interact with the capacity scale simulator, the user's interface APP responsively manages to select or compute the value of the capacity operating rate according to the instantaneous state of interaction between the free setting operator and the capacity scale simulator with the indicator of the capacity operating rate simultaneously showing an instantaneous value of the capacity operating rate, wherein the capacity operating rate shown in the indicator can be an operating percentage, an operating chart or an actual operating value of the relevant operating parameter, wherein when a free setting motion of the free setting operator is ceased, the user interface APP manages to generate the operating variable corresponding to the selection of the capacity operating rate and accordingly operates to transmit a wireless instruction signal carrying a message of the operating variable to the lighting device.

2. The on line free setting method according to claim **1**, wherein the capacity scale simulator is a virtual track, wherein the free setting algorithm is implemented by a visual configuration of the free setting operator coupled with the virtual track and the indicator of the capacity operating rate, wherein the virtual track is designed on the touch screen panel of the mobile device, wherein the free setting operator is slidable by the user's finger along the virtual track with the indicator of the capacity operating rate simultaneously showing an instantaneous value of the changing capacity operating rate while the sliding motion of the free setting operator is being conducted, wherein the value shown in the indicator of the capacity operating rate can be the operating percentage, the operating chart or the actual operating value of the operating parameter, wherein the full length of the virtual track represents a simulation of the value of the maximum operating capacity of the operating parameter, wherein the capacity operating rate is determined by a parking location of the free setting operator on the virtual track when the sliding motion stops.

3. The on line free setting method according to claim **2**, wherein the operating variable of the operating parameter is the capacity operating rate to be wirelessly transmitted to the lighting device for controlling and setting a relevant operating parameter, wherein the capacity operating rate is determined by measuring a ratio of the length of the parking location on the virtual track from the starting point against the total length of the virtual track, wherein the ratio is

further rounded off to the closest integer to become the operating variable for setting the operating parameter selected by the use.

4. The on line free setting method according to claim **2**, wherein the operating variable is the value of the operating parameter selected by the user, wherein the full length of the virtual track is divide into N number of operating domains with each of the N number domain respectively representing a value of the capacity operating rate of the operating parameter, wherein the N number operating domains are aligned on the virtual track according to a sequence of increasing pattern of the N number operating domains, wherein each operating domain is assigned a location code to be used for picking a corresponding capacity operating rate in a data base stored in the user interface APP, wherein the data base comprises a full range of N sets of capacity operating rate corresponding to each of the operating domains configured on the virtual track for each operating parameter, wherein the parking location of the free setting operator on the virtual track represents a selection of the capacity operating rate chosen by the user to be used for setting the value of the operating parameter, wherein the user interface APP comprises at least one subroutine to process at least one capacity operating rate selected by the user into one operating parameter, wherein the operating parameter is wirelessly transmitted to the lighting device.

5. The on line free setting method according to claim **1**, wherein the capacity scale simulator is a capacity free running subroutine and the free setting operator is a virtual button, wherein the free setting algorithm is implemented by a visual configuration of the virtual button, the capacity free running subroutine integrated with the virtual button and the indicator of the capacity operating rate, wherein the virtual button is designed on the touch screen panel of the mobile device, wherein when the virtual button is continuously touched by a user's finger, the user interface APP operates to activate the capacity free running subroutine to gradually increase the capacity operating rate from a minimum level to a maximum level and then from the maximum level to the minimum level to complete a full cycle of free running motion, wherein during a free running cycle period the instantaneous value of the changing capacity operating rate is simultaneously shown in the indicator of the capacity operating rate, wherein the value of capacity operating rate can be the operating percentage, the operating chart or the actual operating value of the operating parameter, wherein the moment at which the user's finger is removed from the virtual button, the capacity free running motion is instantly ceased with the capacity operating rate thereby being locked in at the instantaneous level of the last moment of the free running motion, wherein the time length of a half cycle period of the free running motion represents a simulation of the value of the maximum operating capacity of the operating parameter, wherein the capacity operating rate is determined by the time length the user's finger staying in touch screen panel with the virtual button compared with the time length of a half cycle period of the free running motion.

6. The on line free setting method according to claim **5**, wherein the operating variable of the operating parameter is the capacity operating rate to be wirelessly transmitted to the lighting device for controlling and setting a relevant operating parameter, wherein the capacity operating rate is determined by measuring a ratio of the time length of the virtual button being continuously touched by the user's finger in each half cycle period against the time length of the half cycle period of the free running motion, wherein the ratio is further rounded off to the closest integer to become the operating variable for setting the operating parameter selected by the use.

7. The on line free setting method according to claim **5**, wherein the operating variable is the value of the operating parameter selected by the user, wherein the time length of the half cycle period of the free running motion is divide into N number of operating time domains with each of the N number operating time domain respectively representing a value of the capacity operating rate for setting the operating parameter, wherein the N number operating time domains are aligned in the half cycle time period according to a sequence of increasing pattern of the N number operating time domains, wherein each operating time domain is assigned a location code to be used for picking a corresponding capacity operating rate in a data base stored in the user interface APP, wherein the data base comprises a full range of N sets of capacity operating rates corresponding to each of the operating time domains configured in the half cycle period of the free running motion for each operating parameter, wherein the time length during which the virtual button is continuously touched represents a selection of the capacity operating rate chosen by the user to be used for setting the value of the operating parameter, wherein the user interface APP comprises at least one subroutine to process at least one capacity operating rate selected by the user into one operating parameter, wherein the operating parameter is wirelessly transmitted to the lighting device.

8. The on line free setting method according to claim **1**, wherein the mobile device is a mobile phone, a pad, a PDA, a notebook, a smart watch, a smart speaker or a remote controller featured with a capacity to download an APP from an Internet or a cloud server.

9. A LED security light, comprising:

a light emitting unit comprising an LED load;

a loading and power control unit;

a photo sensor;

a motion sensor;

a power supply unit; and

an external control unit, electrically coupled with the loading and power control unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the photo sensor, the motion sensor and the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light emitting unit such that the light emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the photo sensor, the motion sensor and the external control unit;

wherein at dusk when an ambient light detected by the photo sensor is lower than a first predetermined value, the loading and power control unit operates to turn on the light emitting unit to perform a low level illumination mode;

wherein when a motion signal is detected by the motion sensor, the loading and power control unit operates to increase the average electric current delivered to the LED load of the light emitting unit to perform a high

level illumination mode for a preset time period before being switched back to the low level illumination mode;

wherein at dawn when the ambient light detected by the photo sensor is higher than a second predetermined value, the light emitting unit is switched off by the loading and power control unit;

wherein the external control unit is a wireless receiver electrically coupled with the controller to receive and decode at least a wireless instruction signal into an operating variable interpretable to the controller, wherein the controller further comprises at least one subroutine for processing the operating variable and adjusting a relevant control signal for performing at least one operating parameter according to the operating variable received from the wireless receiver, wherein the operating variable represents a setting decision of capacity operating rate for each functional category of operating parameters of the LED security light set by a user through an APP preloaded in a mobile device, wherein the operating parameter is used for controlling at least one lighting characteristics of the LED security light including timer settings, light intensity settings, color temperature settings or detection sensitivity settings.

10. The LED security light according to claim **9**, further comprising:

a user interface APP comprising at least one free setting algorithm preloaded in the mobile device to transform the user's setting decision(s) into an operating variable(s), wherein the user interface APP is operable on a touch screen panel of the mobile device;

wherein when the user interface APP is activated and concluded with at least one setting decision, the user interface APP manages to transmit via the mobile device at least one wireless instruction signal carrying a message of the operating variable(s) to the LED security light, wherein the operating variable(s) is used for processing or setting the operating parameter(s) of the LED security light.

11. The LED security light according to claim **10**, wherein the free setting algorithm is a capacity scale simulation implemented by a visual configuration of a free setting operator incorporated with a capacitor scale simulator and an indicator of the capacity operating rate to facilitate the user's decision making process in setting a desired level of the operating parameter, wherein when the free setting operator is activated by the user to interact with the capacity scale simulator, the user interface APP responsively manages to gradually adjust the value of the capacity operating rate according to the instantaneous state of interaction between the free setting operator and the capacity scale simulator with the indicator of the capacity operating rate simultaneously showing an instantaneous state of the capacity operating rate, wherein the capacity operating rate shown in the indicator can be an operating percentage, an operating chart or an actual operating value of the relevant operating parameter, wherein when a free setting motion of the free setting operator is ceased with at least one setting decision, the user interface APP manages to generate the operating variable corresponding to a selection of the capacity operating rate and accordingly operates to transmit a wireless instruction signal carrying a message of the operating variable to the LED security light for setting the relevant operating parameter.

12. The LED security light according to claim **11**, wherein the capacity scale simulator is a virtual track, wherein the free setting algorithm is implemented by a visual configuration of the free setting operator, the virtual track coupled with the free setting operator and the indicator of the capacity operating rate, wherein the free setting operator is slidable by the user's finger along the virtual track with the indicator of the capacity operating rate simultaneously showing instantaneous state of the changing capacity operating rate while the sliding motion of the free setting operator is being conducted, wherein the state shown in the indicator of the capacity operating rate can be the operating percentage, the operating chart or the actual operating value of the operating parameter, wherein the full length of the virtual track represents a simulation of the value of the maximum operating capacity of the operating parameter, wherein the capacity operating rate is determined by a parking location of the free setting operator on the virtual track when the sliding motion stops.

13. The LED security light according to claim **11**, wherein the capacity scale simulator is a capacity free running subroutine and the free setting operator is a virtual button, wherein the free setting algorithm is implemented by a visual configuration of the virtual button, the capacity free running subroutine integrated with the virtual button and an indicator of the capacity operating rate, wherein the virtual button is designed on the touch screen panel of the mobile device, wherein when the virtual button is continuously touched by a user's finger, the user interface APP operates to activate the capacity free running subroutine to gradually increase the capacity operating rate from a minimum level to a maximum level and then from the maximum level to the minimum level to complete a full cycle of free running motion, wherein during a free running cycle period the instantaneous state of the changing capacity operating rate is simultaneously shown in the indicator of the capacity operating rate, wherein the state of the capacity operating rate can be the operating percentage, the operating chart or the actual operating value of the operating parameter, wherein the moment at which the user's finger is removed from the virtual button, the free running motion is instantly ceased with the capacity operating rate thereby being locked in at the instantaneous level of the last moment of the free running motion, wherein the time length of a half cycle period of the free running motion represents a simulation of the value of the maximum operating capacity of the operating parameter wherein the capacity operating rate is determined by the time length the user's finger staying in touch screen panel with the virtual button compared with the time length of a half cycle period of the free running motion.

14. The LED security light according to claim **9**, wherein the wireless receiver is a Wi-Fi wireless receiver, a Blue Tooth wireless receiver, a Zig Bee wireless receiver or a RF wireless receiver.

15. The LED security light according to claim **9**, wherein the operating parameter is for setting a timer for performing a manual override illumination mode, wherein the security light is controlled by the photo sensor and the timer for performing a general illumination mode with the motion sensor being temporarily disabled.

16. The LED security light according to claim **15**, wherein the timer is a time length setting timer or a clock time setting timer.

17. The LED security light according to claim **9**, wherein the operating parameter is for setting the preset time period for performing the high level illumination mode.

18. The LED security light according to claim **9**, wherein the operating parameter is for setting the detection distance of the motion sensor.

19. The LED security light according to claim **9**, wherein the operating parameter is for setting the light intensity of the low level illumination mode or the high level illumination mode.

20. The LED security light according to claim **9**, wherein the operating parameter is for setting the color temperature of the low level illumination mode or the high level illumination mode.

21. A security light control device, comprising:

a loading and power control unit;

a photo sensor;

a motion sensor;

a power supply unit; and

an external control unit;

wherein the security light control device is electrically connectable to a light emitting unit configured with an LED load, wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the photo sensor, the motion sensor and the switching circuitry;

wherein the switching circuitry is electrically connectable between a power source of the power supply unit and the light emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to the LED load of the light emitting unit such that the light emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the photo sensor, the motion sensor and the external control unit;

wherein at dusk when an ambient light detected by the photo sensor is lower than a first predetermined value, the loading and power control unit operates to turn on the light emitting unit to perform a low level illumination mode;

wherein when a motion signal is detected by the motion sensor, the loading and power control unit operates to increase the average electric current delivered to the LED load of the light emitting unit to perform a high level illumination mode for a preset time period before being switched back to the low level illumination mode;

wherein at dawn when the ambient light detected by the photo sensor is higher than a second predetermined value, the light emitting unit is switched off by the loading and power control unit;

wherein the external control unit is a wireless receiver electrically coupled with the controller to receive and decode wireless instruction into at least one operating variable of an operating parameter used to operate the security light control device, wherein the controller further comprises at least one subroutine for processing the operating variable received from the wireless receiver, wherein the operating variable is set by a user through an APP loaded in a mobile device, wherein the operating parameter is used for controlling at least one lighting characteristic of the security light control device.

22. The security light control device according to claim **21**, wherein the wireless receiver is a Wi-Fi wireless receiver, a Blue Tooth wireless receiver, a Zig Bee wireless receiver or a RF wireless receiver.

23. The security light control device according to claim **21**, wherein the operating parameter is for setting a timer for performing a manual override illumination mode, wherein the security light is controlled by the photo sensor and the timer for performing a general illumination mode with the motion sensor being temporarily disabled.

24. The security light control device according to claim **23**, wherein the timer is a time length setting timer or a clock time setting timer.

25. The security light control device according to claim **21**, wherein the operating parameter is for setting the preset time period for performing the high level illumination mode.

26. The security light control device according to claim **21**, wherein the operating parameter is for setting the detection distance of the motion sensor.

27. The security light control device according to claim **21**, wherein the operating parameter is for setting the light intensity of the low level illumination mode or the high level illumination mode.

28. The security light control device according to claim **21**, wherein the operating parameter is for setting color temperature of the low level illumination mode or the high level illumination mode.

29. The security light control device according to claim **21**, further comprising:

a user interface APP comprising at least one free setting algorithm preloaded in the mobile device to transform the user's setting decision(s) into the operating variable(s), wherein the user interface APP is operable on a touch screen panel of the mobile device;

wherein when the user interface APP is activated and concluded with at least one setting decision, the user interface APP manages to transmit via the mobile device at least one wireless instruction signal carrying a message of the operating variable to the security light control device, wherein the operating variable is used for processing or setting the operating parameter of the security light control device.

30. The security light control device according to claim **21**, wherein the free setting algorithm is a capacity scale simulation implemented by a visual configuration of a free setting operator incorporated with a capacity scale simulator and an indicator of the capacity operating rate to facilitate the user's decision making process in setting a desired level of operating parameter, wherein when the free setting operator is activated by the user to interact with the capacity scale simulator, the user interface APP responsively manages to gradually adjust the value of the capacity operating rate according to the instantaneous state of interaction between the free setting operator and the capacity scale simulator with the indicator of the capacity operating rate simultaneously showing an instantaneous state of the capacity operating rate, wherein the capacity operating rate shown in the indicator can be an operating percentage, an operating chart or an actual operating value of the operating parameter, wherein when a free setting motion of the free setting operator is ceased, the user interface APP manages to generate the operating variable corresponding to a selection of the capacity operating rate and accordingly operates to transmit a wireless instruction signal carrying a message of the operating variable to the security light control device.

31. The security light control device according to claim **30**, wherein the capacity scale simulator is a virtual track, wherein the free setting algorithm is implemented by the visual configuration of the free setting operator, the virtual track coupled with the free setting operator and the indicator of the capacity operating rate, wherein the free setting

operator is slidable by the user's finger along the virtual track with the indicator of the capacity operating rate simultaneously showing instantaneous state of the changing capacity operating rate while the sliding motion of the free setting operator is being conducted, wherein the state shown in the indicator of the capacity operating rate can be the operating percentage, the operating chart or the actual operating value of the operating parameter, wherein the full length of the virtual track represents a simulation of the value of the maximum operating capacity of the operating parameter, wherein the capacity operating rate is determined by a parking location of the free setting operator on the virtual track when the sliding motion stops.

32. The security light control device according to claim **30**, wherein the capacity scale simulator is a capacity free running subroutine and the free setting operator is a virtual button, wherein the free setting algorithm is implemented by the visual configuration of the virtual button, the capacity free running subroutine integrated with the virtual button and an indicator of the capacity operating rate, wherein the virtual button is designed on the touch screen panel of the mobile device, wherein when the virtual button is continuously touched by a user's finger, the user interface APP operates to activate the capacity free running subroutine to gradually increase the capacity operating rate from a minimum level to a maximum level and then from the maximum level to the minimum level to complete a full cycle of free running motion, wherein during a free running cycle period the instantaneous state of the changing capacity operating rate is simultaneously shown in the indicator of the capacity operating rate, wherein the state of capacity operating rate can be the operating percentage, the operating chart or the actual operating value of the operating parameter, wherein the moment at which the user's finger is removed from the virtual button, the free running motion is instantly ceased with the capacity operating rate thereby being locked in at the instantaneous level of the last moment of the free running motion, wherein the time length of a half cycle period of the free running motion represents a simulation of the value of the maximum operating capacity of the operating parameter, wherein the capacity operating rate is determined by the time length the user's finger staying in touch screen panel with the virtual button compared with the time length of a half cycle period of the free running motion.

33. The security light control device according to claim **21**, wherein the controller is a microcontroller programmable for generating the control signal.

34. The security light control device according to claim **21**, wherein the controller is an application specific integrated circuit (ASIC) customized for generating the control signal.

35. The security light control device according to claim **21**, wherein the security light control device is detachably connected to a LED lighting load via a screw in or plug in configuration, wherein the security light control device is configured with a socket base and the LED lighting load is configured with a screw in head or a bi-pin twist in head for making electrical connection with each other.

36. A security light control device, comprising:

a loading and power control unit;

a photo sensor;

a motion sensor;

a power supply unit; and

an external control unit;

wherein the security light control device is electrically connectable to a light emitting unit configured with an LED load, wherein the loading and power control unit comprises a controller and a switching circuitry,

wherein the controller is electrically coupled with the photo sensor, the motion sensor and the switching circuitry;

wherein the switching circuitry is electrically connectable between a power source of the power supply unit and the light emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to the LED load of the light emitting unit such that the light emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the photo sensor, the motion sensor and the external control unit;

wherein at dusk when an ambient light detected by the photo sensor is lower than a first predetermined value, the light emitting unit is switched on by the photo sensor while remaining in a turned off state;

wherein when a motion signal is detected by the motion sensor, the loading and power control unit manages the switching circuitry to deliver an average electric power to the light emitting unit for performing a high level illumination mode for a preset time period before and then the light emitting unit is switched back to the turned off state;

wherein at dawn when the ambient light detected by the photo sensor is higher than a second predetermined value, the light emitting unit is switched off by the photo sensor;

wherein when an ambient light detected by the photo sensor is lower than a first predetermined value, the lighting load is activated by the photo sensor, wherein when the ambient light detected by the photo sensor is higher than a second predetermined value, the lighting load is deactivated by the photo sensor, wherein when a motion intrusion is detected by the motion sensor, the controller of the loading and power control unit outputs a control signal to control the conduction rate of the controllable semiconductor switching device to deliver an average electric power to the lighting load;

wherein the external control unit is a wireless receiver electrically coupled with the controller to receive and decode wireless instruction(s) into at least one operating variable of an operating parameter used to operate the security light control device, wherein the controller further comprises at least one subroutine for processing and for setting the operating parameter according to the operating variable received from the wireless receiver, wherein the operating variable represents a setting decision made and operated by a user through an APP preloaded in a mobile device, wherein the operating parameter is used for controlling at least one lighting characteristic of the security light control device.

37. The security light control device according to claim **36**, wherein the wireless receiver is a Wi-Fi wireless receiver, a Blue Tooth wireless receiver, a Zig Bee wireless receiver or a RF wireless receiver.

38. The security light control device according to claim **36**, wherein the operating parameter is for setting a timer for performing a manual override illumination mode, wherein the security light is controlled by the photo sensor and the timer for performing a general illumination mode with the motion sensor being temporarily disabled.

39. The security light control device according to claim **38**, wherein the timer is a time length setting timer or a clock time setting timer.

40. The security light control device according to claim **36**, wherein the operating parameter is for setting the preset time period for performing the high level illumination mode.

41. The security light control device according to claim **36**, wherein the operating parameter is for setting the detection distance of the motion sensor.

42. The security light control device according to claim **36**, wherein the operating parameter is for setting the light intensity of the high level illumination mode.

43. The security light control device according to claim **36**, wherein the operating parameter is for setting the color temperature of the high level illumination mode.

44. The security light control device according to claim **36**, further comprising:

a user interface APP comprising at least one free setting algorithm preloaded in the mobile device to transform the user's setting decision into the operating variable, wherein the user interface APP is operable on a touch screen panel of the mobile device;

wherein when the user interface APP is activated and concluded with at least one setting decision, the user interface APP manages to transmit via the mobile device at least one wireless instruction signal carrying a message of the operating variable to the LED security light control device, wherein the operating variable is used for processing or setting the operating parameter of the security light control device.

45. The security light control device according to claim **44**, wherein the free setting algorithm is a capacity scale simulation implemented by a visual configuration of a free setting operator incorporated with a capacity scale simulator and an indicator of the capacity operating rate to facilitate the user's decision making process in setting a desired level of operating parameter, wherein when the free setting operator is activated by the user to interact with the capacity scale simulator, the user interface APP responsively manages to gradually adjust the value of the capacity operating rate according to the instantaneous state of interaction between the free setting operator and the capacity scale simulator with the indicator of the capacity operating rate simultaneously showing an instantaneous state of the capacity operating rate, wherein the capacity operating rate shown in the indicator can be an operating percentage, an operating chart or an actual performance value of the operating parameter, wherein when a free setting motion of the free setting operator is ceased with at least one setting decision, the user interface APP responsively manages to generate the operating variable corresponding to a selection of the capacity operating rate and accordingly operates to transmit a wireless instruction signal carrying a message of the operating variable to the security light control device.

46. The security light control device according to claim **45**, wherein the capacity scale simulator is a virtual track, wherein the free setting algorithm is implemented by the visual configuration of the free setting operator, the virtual track coupled with the free setting operator and the indicator of the capacity operating rate, wherein the free setting operator is slidable by the user's finger along the virtual track with the indicator of the capacity operating rate simultaneously showing instantaneous state of the changing capacity operating rate while the sliding motion of the free setting operator is being conducted, wherein the state shown in the indicator of the capacity operating rate can be the operating percentage, an operating chart or the actual operating value of the operating parameter, wherein the full length of the virtual track represents a simulation of the value of the maximum operating capacity of the operating parameter, wherein the capacity operating rate is determined by a parking location of the free setting operator on the virtual track when the sliding motion stops.

47. The security light control device according to claim **45**, wherein the capacity scale simulator is a capacity free running subroutine and the free setting operator is a virtual button, wherein the free setting algorithm is implemented by the visual configuration of the virtual button, the capacity free running subroutine integrated with the virtual button and an indicator of the capacity operating rate, wherein the virtual button is designed on the touch screen panel of the mobile device, wherein when the virtual button is continuously touched by a user's finger, the user interface APP operates to activate the capacity free running subroutine to gradually increase the capacity operating rate from a minimum level to a maximum level and then from the maximum level to the minimum level to complete a full cycle of free running motion, wherein during a free running cycle period the instantaneous state of the changing capacity operating rate is simultaneously shown in the indicator of the capacity operating rate, wherein the state of capacity operating rate can be the operating percentage, an operating chart or the actual operating value of the operating parameter, wherein the moment at which the user's finger is removed from the virtual button, the free running motion is instantly ceased with the capacity operating rate thereby being locked in at the instantaneous level of the last moment of the free running motion, wherein the time length of a half cycle period of the free running motion represents a simulation of the value of the maximum operating capacity of the operating parameter, wherein the capacity operating rate is determined by the time length the user's finger staying in touch screen panel with the virtual button compared with the time length of a half cycle period of the free running motion.

48. The security light control device according to claim **36**, wherein the controller is a microcontroller programmable for generating the control signal.

49. The security light control device according to claim **36**, wherein the controller is an application specific integrated circuit (ASIC) customized for generating the control signal.

50. The security light control device according to claim **36**, wherein the security light control device is detachably connected to a LED lighting load via a screw in or plug in configuration, wherein the security light control device is configured with a socket base and the LED lighting load is configured with a screw in head or a bi-pin twist in head for making electrical connection with each other.

51. The security light control device according to claim **36**, wherein the security light control device is non-detachably connected to the LED load.

52. A LED security light control device, comprising:

a loading and power control unit;

a photo sensor;

a power supply unit; and

an external control unit, electrically coupled with the loading and power control unit;

wherein the LED security light control device is connectable to a light emitting unit configured with an LED load, wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the photo sensor, the motion sensor and the switching circuitry; wherein the switching circuitry comprises at least one

unidirectional semiconductor switching device, wherein the switching circuitry is electrically connectable between a power source and the lighting load, wherein the controller outputs a control signal to control the switching circuitry for delivering different average electric power(s) to drive the lighting load for generating different illumination modes according to control signal(s) received from the photo sensor and the external control unit;

wherein when an ambient light detected by the photo sensor is lower than a first predetermined value, the lighting load is thereby turned on by the loading and power control unit to generate a first level illumination mode for a first predetermined duration, then the lighting load is switched to a second level illumination mode, wherein a light intensity of the first level illumination mode is higher than a light intensity of the second illumination mode; wherein when the ambient light detected by the photo sensor is higher than a second predetermined value, the lighting load is thereby turned off by the loading and power control unit;

wherein the external control unit is a wireless receiver electrically coupled with the controller to receive and decode a wireless external control signal into operating variable, wherein the controller further comprises at least one subroutine for processing the operating variable, wherein the operating variable represents a setting decision made and operated by a user through an APP loaded in a mobile device, wherein the operating parameter is used for controlling at least one lighting characteristic of the LED security light control device.

53. The LED security light control device according to claim **52**, wherein the wireless receiver is a Wi-Fi wireless receiver, a Blue Tooth wireless receiver, a Zig Bee wireless receiver or a RF wireless receiver.

54. The LED security light control device according to claim **52**, wherein the operating parameter is for controlling the time length of the first predetermined duration for performing the first level illumination mode.

55. The LED security light control device according to claim **52**, wherein the operating parameter is for setting the light intensity of at least the first level illumination mode or the second level illumination mode.

56. The LED security light control device according to claim **52**, further comprising:

a user interface APP comprising at least one free setting algorithm preloaded in the mobile device to transform the user's setting decision into the operating variable, wherein the user interface APP is operable on a touch screen panel of the mobile device;

wherein when the user interface APP is activated and concluded with at least one setting decision, the user interface APP manages to transmit via the mobile device at least one wireless instruction signal carrying a message of the operating variable to the LED security light control device, wherein the operating variable is used for processing or setting operating parameter of the LED security light control device.

57. The LED security light control device according to claim **56**, wherein the free setting algorithm is a capacity scale simulation implemented by a visual configuration of a free setting operator incorporated with a capacity scale simulator and an indicator of capacity operating rate to facilitate the user's decision making process in setting a desired level of the operating parameter, wherein when the free setting operator is activated by the user to interact with the capacity scale simulator, the user interface APP responsively manages to gradually adjust the value of the capacity operating rate according to the instantaneous state of interaction between the free setting operator and the capacity scale simulator with the indicator of the capacity operating rate simultaneously showing an instantaneous state of the capacity operating rate, wherein the capacity operating rate shown in the indicator can be an operating percentage, an operating chart or an actual operating value of the operating parameter, wherein when a free setting motion of the free setting operator is ceased, the user interface APP manages to generate the operating variable corresponding to a selection of the capacity operating rate and accordingly operates to transmit a wireless instruction signal carrying a message of the operating variable to the LED security light control device.

58. The LED security light control device according to claim **57**, wherein the capacity scale simulator is a virtual track, wherein the free setting algorithm is implemented by the visual configuration of the free setting operator, the virtual track coupled with the free setting operator and the indicator of the capacity operating rate, wherein the free setting operator is slidable by the user's finger along the virtual track with the indicator of the capacity operating rate simultaneously showing instantaneous state of the changing capacity operating rate while the sliding motion of the free setting operator is being conducted, wherein the state shown in the indicator of the capacity operating rate can be the operating percentage, the operating chart or the actual operating value of the operating parameter, wherein the full length of the virtual track represents a simulation of the value of the maximum operating capacity of the operating parameter, wherein the capacity operating rate is determined by a parking location of the free setting operator on the virtual track when the sliding motion stops.

59. The LED security light control device according to claim **57**, wherein the capacity scale simulator is a capacity free running subroutine and the free setting operator is a virtual button, wherein the free setting algorithm is implemented by the visual configuration of the virtual button, the capacity free running subroutine integrated with the virtual button and an indicator of the capacity operating rate, wherein the virtual button is designed on the touch screen panel of the mobile device, wherein when the virtual button is continuously touched by a user's finger, the user interface APP operates to activate the capacity free running subroutine to gradually increase the capacity operating rate from a minimum level to a maximum level and then from the maximum level to the minimum level to complete a full cycle of free running motion, wherein during a free running cycle period the instantaneous state of the changing capacity operating rate is simultaneously shown in the indicator of the capacity operating rate, wherein the state of capacity operating rate can be the operating percentage, the operating chart or the actual operating value of the operating parameter, wherein the moment at which the user's finger is removed from the virtual button, the free running motion is instantly ceased with the capacity operating rate thereby being locked in at the instantaneous level of the last moment of the free running motion, wherein the time length of a half cycle period of the free running motion represents a simulation of the value of the maximum operating capacity of the relevant operating parameter, wherein the capacity operating rate is determined by the time length the user's finger staying in touch screen panel with the virtual button compared with the time length of a half cycle period of the free running motion.

60. The LED security light control device according to claim **52**, wherein the controller is a microcontroller programmable for generating the control signal.

61. The LED security light control device according to claim **52**, wherein the controller is an application specific integrated circuit (ASIC) customized for generating the control signal.

62. The LED security light control device according to claim **52**, wherein the security light control device is detachably connected to a LED lighting load via a screw in or plug in configuration, wherein the security light control device is configured with a socket base and the LED lighting load is configured with a screw in head or a bi-pin twist in head for making electrical connection with each other.

63. An on line free setting method for setting operating parameter of a ceiling fan with light kit, comprising:

a user interface APP comprising at least one free setting algorithm preloaded in a mobile device to transform a user's setting decision into at least one operating variable of an operating parameter of the ceiling fan with light kit, wherein the user interface APP is operable on a touch screen panel of the mobile device;

wherein when the user interface APP is activated and concluded with at least one setting decision, the user interface APP manages to transmit via the mobile device at least one wireless instruction signal carrying a message of the operating variable to the ceiling fan with light kit, wherein the operating variable is used for processing a value of the operating parameter of the ceiling fan with light kit; and

a microcontroller of the lighting device, designed with a capacity to interpret the wireless instruction signal received by a wireless signal receiver of the lighting device and accordingly manages to output at least one control signal to control and set the value of at least one operating parameter of the ceiling fan with light kit;

wherein the value of the operating parameter is stored in a memory of the microcontroller for repetitive performance, wherein the stored value of the operating parameter is replaceable by a processing of new operating variable selected by the user;

wherein the operating parameter is used for controlling at least one of various lighting and electrical characteristics of the ceiling fan with light kit including timer settings, fan speed settings and fan rotation direction settings, light intensity settings and light color temperature settings;

wherein the free setting algorithm is a capacity scale simulation implemented by a visual configuration of a free setting operator incorporated with a capacity scale simulator and an indicator of the capacity operating rate to facilitate the user's decision making process in setting a desired level of the operating parameter, wherein when the free setting operator is activated by the user to interact with the capacity scale simulator, the user interface APP responsively manages to gradually adjust the value of the capacity operating rate according to the instantaneous state of interaction between the free setting operator and the capacity scale simulator with the indicator of the capacity operating rate simultaneously showing an instantaneous state of the capacity operating rate, wherein the capacity operating rate shown in the indicator can be an operating percentage, an operating chart or an actual operating value of the relevant operating parameter, wherein when a free setting motion of the free setting operator is ceased, the user interface APP manages to generate the operating variable corresponding to the selection of the capacity operating rate and accordingly operates to transmit a wireless instruction signal carrying a message of the operating variable to the ceiling fan with light kit.

64. The on line free setting method according to claim **63**, wherein the mobile device is a mobile phone, a pad, a PDA, a notebook, a smart watch, a smart speaker or a remote controller featured with a capacity to download an APP from an Internet or a cloud server.

65. The on line free setting method according to claim **63**, wherein the ceiling fan is a DC motor fan and the light kit is a LED lighting device.

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